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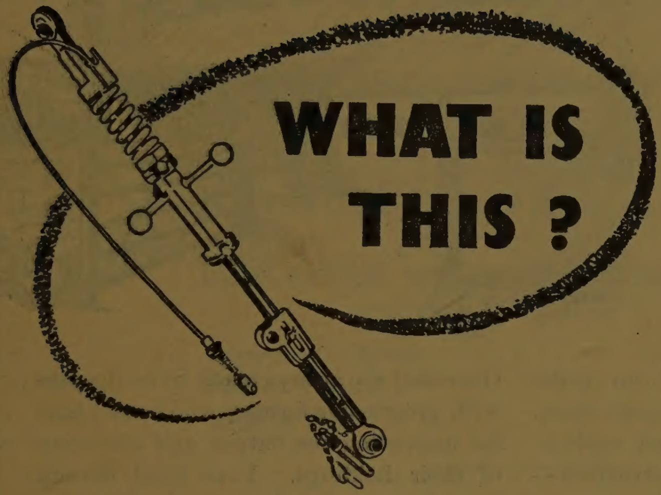
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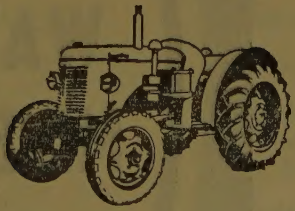

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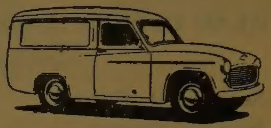

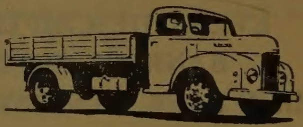

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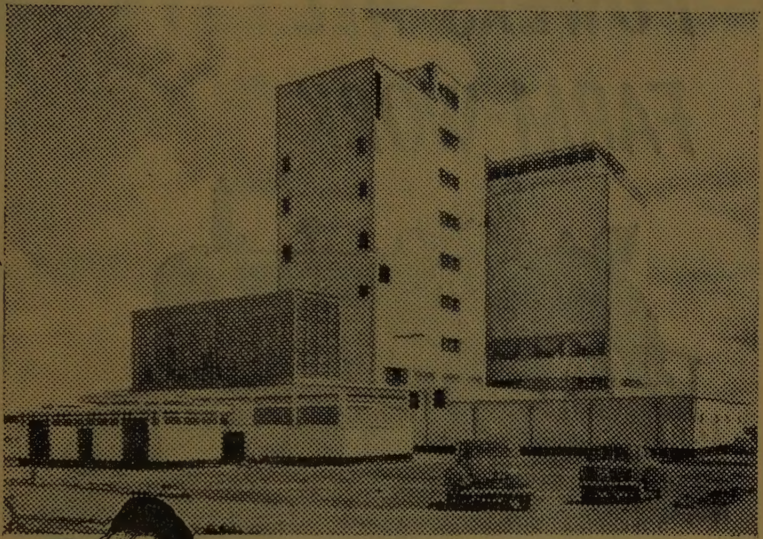

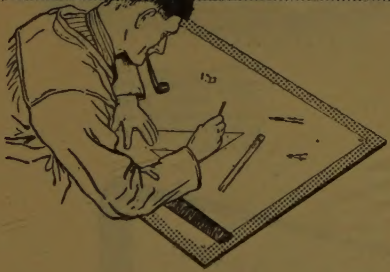

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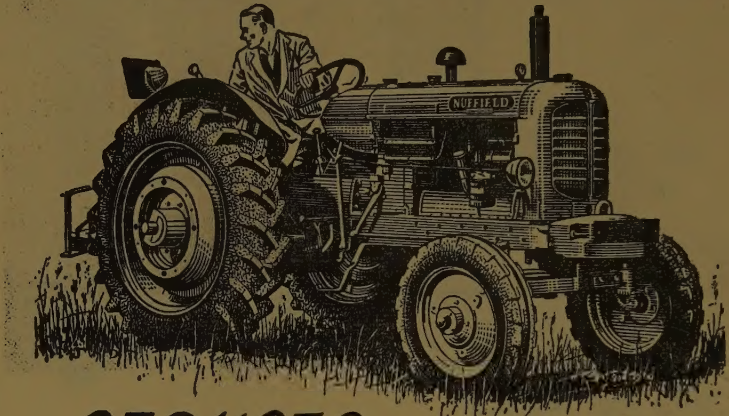

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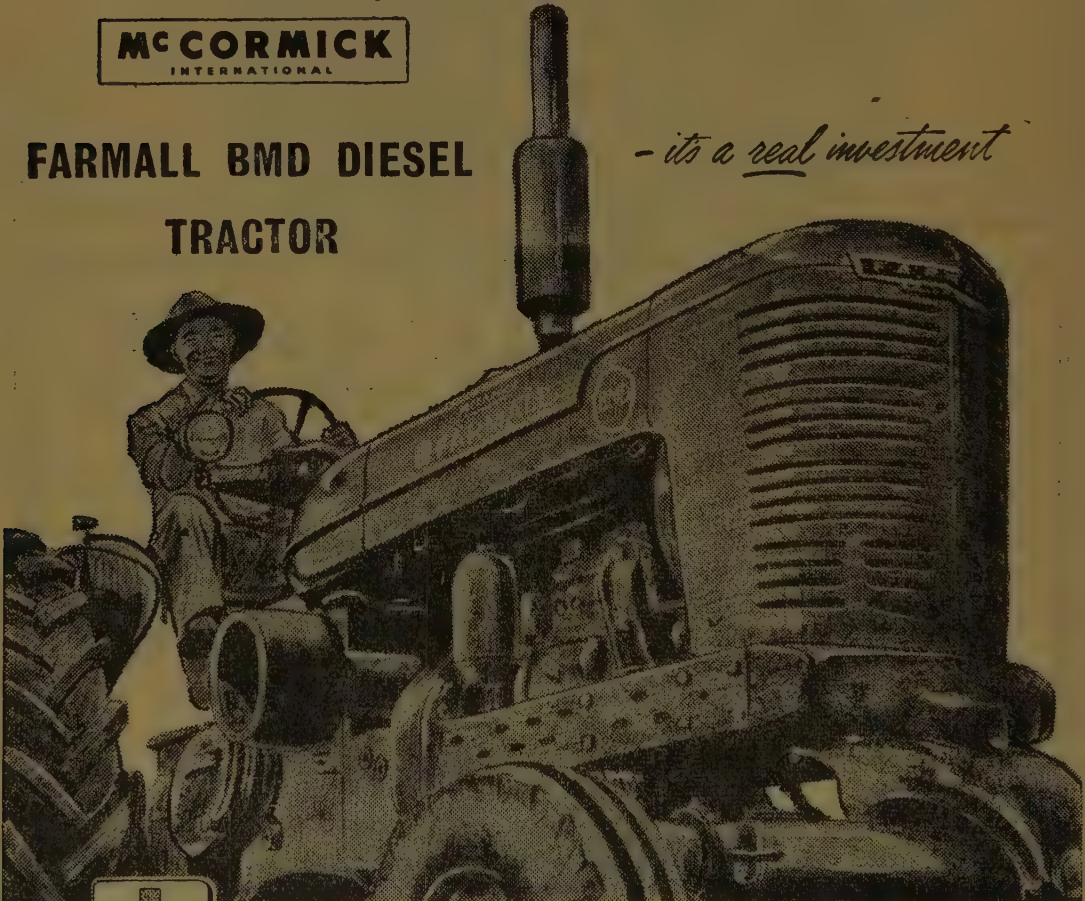

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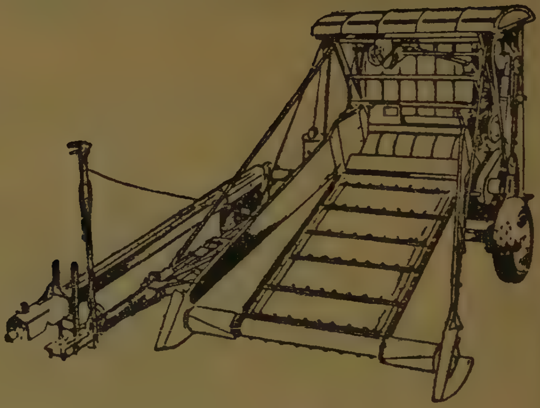

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VOL. XIX—No. 4 APRIL, 1954

Printed and published by the Government Printer, Nairobi

Issued under the Authority of the East Africa High Commission and published every three months—July, October, January, April. Volume consists of four issues (commencing July issue)

Editorial Board: Director of E.A. Agriculture and Forestry Research Organization. Director of E.A. Veterinary Research Organization. Directors of Agriculture, Kenya, Tanganyika, Uganda and Zanzibar. Directors of Veterinary Services, Kenya, Tanganyika and Uganda. Conservators of Forests, Kenya, Tanganyika and Uganda.

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EDITOR: D. W. DUTHIE

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Forestry is a long-term business and consequently needs long-term planning and long-term finance. This is impossible without a firm Forest Policy, and this policy must be understood by all—by the department or business concerned, by the Administration at all levels, and above all by the people of the country.

In the report of the Tanganyika Forest Department for 1952, which has recently come to hand, the first few pages are devoted to the fact that at last Tanganyika has a definite Forest Policy, which was presented to the Legislative Assembly as Sessional Paper No. 1 of 1953, and was passed on February 12th, 1953.

Uganda's Forest Policy was presented in the form of an "Announcement by His Excellency the Governor" as a supplement to the *Uganda Gazette* of June 15th, 1948. The Forest Policy of Zanzibar was announced by His Excellency the British Resident at a public meeting in 1949 at which His Highness the Sultan, and the leading personalities of Zanzibar's many races were present.

The broad lines of Kenya's Forest Policy were published in the Report of the Development Committee, Volumes I and II, which received the approval of Kenya Legislative Council. The Report of the Forestry Sub-Committee Appendix 7, Vol. II, accepted in principle by the main Development Committee, covered a very wide field of forest policy, much of which has been implemented in the intervening years. In 1953, the Legislative Council adopted in principle White Paper No. 1 of 1952—A Statement of Forest Policy. With the passage of time and the accumulation of experience, Forest Policy is again under review in Kenya, and a comprehensive statement of policy is in the course of preparation.

A Forest Policy should represent a decision at the highest level in a State, and be enunciated formally for the guidance of all, and, to ensure permanence, it must ultimately become the will of the people. This can best be stated by quoting part of the speech made by the Honourable The Member for Agriculture and Natural Resources when introducing the Paper in the Tanganyika Legislative Council. ". . . There are many good reasons, Sir, for presenting a formal statement of Forest Policy to this Council for approval. The first resolution of the first Empire Forestry Conference held in 1920 recommended that each Government of the Empire should lay down a definite and adequate Forest Policy to be administered by a properly constituted Forest Service. This resolution has been reaffirmed by other subsequent conferences. Again a resolution similar in substance was passed by the more recent Inter-African Forestry Conference. Moreover, successive Forest Advisors to the Secretary of State have endorsed these recommendations, and I understand that Honourable Members of this Council have from time to time asked for a statement of Government's Forest Policy. But perhaps the most cogent reason for defining policy is that forestry is, from its very nature, long range, and long-term planning is essential.

The efforts and resources devoted to forestry cannot be applied to greatest advantage, and cannot be fully effective unless there is continuity in policy, and in the implementation of that policy. The Forest Department in fact, and with the approval of Government has been striving after certain objectives, but these objectives have never been authoritatively and publicly stated. It is clearly desirable that this should be done and that a clearly defined statement of policy should be laid down for the guidance of all." In point of fact, even as recently as 1952 the Sixth British Commonwealth Forestry Conference held in Canada recommended that:—

(1) The attention of all Commonwealth Governments be drawn to the great need for a continuous and stable forest policy.

(2) Those Governments which have not yet formulated and published a statement of their forest policy be urged to do so without delay, and that all Commonwealth Governments be urged to take action to implement their forest policies.

The Hon. Member went on to point out that the land area of Tanganyika is approximately 343,000 square miles, but the area under forest reserves is only 10,500 square miles, or about 3 per cent, and suggested that this should be raised to about 8 per cent in the next ten years. This sets a definite target to be aimed at and it must be remembered that forest reserves covered 3,780 square miles in 1922 and have been extended by only 6,700 square miles in the past 30 years.

The first paragraph of the policy is "To demarcate and reserve in perpetuity for the benefit of present and future inhabitants of the country, sufficient forested land or land capable of afforestation to preserve and improve local climates and water supplies, stabilize land which is liable to deterioration and provide a sustained yield of forest produce of all kinds for internal use and also for export".

The Annual Report of the Tanganyika Forest Department goes on "In order to achieve this first objective of forest policy, the creation of an adequate forest estate, it will be necessary to place under the permanent control of the Central Government:—

(1) All catchment watersheds and other lands which cannot, even with proper soil conservation practices, be used for agriculture or pasture without risk of soil deterioration or interference with water supplies.

(2) All forested areas the preservation of which is necessary to ensure the protection of the land against floods or erosion or to regulate the water supplies and the flow of streams, or to maintain the climatic conditions suitable for agriculture.

(3) A sufficiency of forest and woodland, and sufficient scrub and grassland capable of afforestation to ensure adequate, accessible and sustained supplies of forest produce of all kinds for local homes, farms and industries, and for the development of the timber industry, both internal and external".

The sessional paper was well received in the Legislative Council and many Members, both European and African, spoke on the subject. In it was particularly stressed that the passing and promulgation of such a policy was useless unless it was to be implemented and that this meant that the necessary funds must be guaranteed for a minimum period of years. On this subject the Hon. the Acting Member for Finance and Economics said ". . . it is the intention of Government to implement it by the provision of the necessary finance, always assuming that the necessary finance can be made available. I have every hope that it can. I cannot, however, regardless of what happens to world prices, or anything else, guarantee it. . . ."

Finally, after some discussion an amendment was proposed and passed ". . . that means should be sought to secure finance in order to ensure the fulfilment of this policy over a medium term".

So much for the official proceedings. They mean that in East Africa we have gone a long way towards avoiding the deterioration of land and the upsetting of a country's economy by the uncontrolled clearing and alienation of land not fit for the purposes to which it was put. We already have many instances of local land destruction by "flogging" it for a period of years with unsuitable crops, and other malpractices. We always have before us the example of the "dust bowl" of the U.S.A., and the cotton lands of the Southern States, and all they have involved in trying to get the land back into production again.

Germany and France have implemented firm Forest Policies for several centuries, India has had one for over a century, and yet it has taken us over 30 years to take heed of the resolution of that first British Empire Forestry Conference in 1920 which was conveyed to each Government of the Empire, and which has been repeated so many times since.

Now at last when we are asked "Why is this area of *miombo* being reserved?" or "Why is this land being planted with softwoods?" or "Why am I fined for taking fuel which I consider belongs to all?", we have an authoritative and sound backing for our answer. Having got this sound backing it is the job of all understanding people, whether forest officers, farmers, administrators, or those with commercial interests, to do their utmost to see that all the inhabitants of the country understand what is going on and why it is going on. In the more advanced and progressive countries, such as France, Germany, the U.S.A., Canada and Australia, great stress is laid on the value of explanations in the schools, which lead to explanations in the homes, and it is probable that the Education Departments of the East African Territories could be of great assistance in this vital matter.

FISHERY RESEARCH IN THE LAKES OF EAST AFRICA

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(*Received for publication on* 19*th December*, 1953)

Fishery research is the study of fish in relation to their environment; little can be learnt about them until we have a fair knowledge of the conditions in which they live. The need for this knowledge is made very obvious to the biologist working on inland fisheries. For example, the same species of fish occur in a number of East African lakes, in some they grow to a considerable size, weighing several pounds, while in others they never exceed a few ounces in weight. No explanation of these facts is likely to arise from investigations confined solely to the study of the fish themselves.

Under natural conditions the number of fish that can live in any lake or pond and the size to which they may grow depends primarily on the fertility of the water. It is therefore important to discover what determines this fertility.

Fertility can be measured in terms of dissolved substances contained in the water, in much the same way as one may describe a soil as being fertile because it contains plenty of plant nutrients, phosphates, nitrates, lime, potash and other essential substances.

Fish cannot of course grow in a simple solution of chemical substances; the basic chemical fertility of the water needs to be converted into plant material on which fish and other animals may feed. Light is necessary for plant growth, so a chemically fertile water will support a high density of plants only if it receives sufficient light. In a lake only the surface waters are illuminated, so only near the surface can the essential work of converting simple chemical substances into organic matter be carried out. Fertile water which remains at the bottom of a lake is no more productive than the rich soil lying on the floor of a dense forest is productive of undergrowth. The water near the bottom of a lake tends to be chemically fertile because it receives nutrients which are released from the mud by decomposition. It is necessary to know something about the way this water is moved from the bottom to the surface. This study of water movements is called hydrology and can be described as a kind of aquatic meteorology. The realization of the potential chemical fertility of a lake depends very largely on whether the hydrological conditions are favourable and cause water from the bottom to be transferred readily to the surface. In some lakes conditions often exist which prevent such mixing of the water, with the result that the productivity of the lake is considerably less than it would be otherwise.

The plants which are the most important as forming food for fish are the algæ, small microscopic plants which live either suspended freely in the water (phytoplankton) or attached to the stems and leaves of higher plants or to the rocks and stones in the shallow littoral regions of a lake. These algæ are either eaten directly by fish, or by the invertebrate fauna, the shrimps, insects and snails which form the food of many fish. It is therefore important to know as much as possible about these invertebrate animals; what species they are, their life histories, and whether their abundance varies from time to time.

Only a few species of fish are herbivorous and can feed directly on plants; they play, however, a very significant part in the general economy of the African lakes, so special mention will be made of them later on.

Crocodiles, otters and birds, such as cormorants, darters and pelicans, all form part of the environment of fish and some knowledge of these predatory animals is necessary before a proper understanding can be reached regarding the populations of fish living in a lake.

In the lakes of East African there are nearly three hundred distinct species of indigenous fish; the accurate identification of most of these fish is difficult. Much work remains to be done on their taxonomy and very little is known about their habits and life histories. Fish of economic importance to man are limited to about fifty species, but undoubtedly the fish of greatest commercial value belong to the genus *Tilapia;* all species of *Tilapia* are herbivorous, some feed on algæ while others eat higher plants.

It may seem that the various problems presented by a lake could be tackled one at a time. For instance, one might think it possible to investigate the chemical situation first, and then the plants at another time, and follow these studies with observations on the fish and other animals. On reflection it is clear that this is only possible to a limited extent, because the plants, by using up the chemical constituents in the water, affect the simple conception that fertility can be assessed in chemical terms, and because the animals, by their feeding habits, affect the standing crop of plants, and because both the plants and animals by their death and ultimate decay add to the concentrations of chemical substances in solution. This cycle of biological events occurs in all lakes, but the rate at which it proceeds as a whole, and the rate of the individual processes, is affected both by conditions within the lake itself and by external climatic conditions. Under tropical conditions, where there is little seasonal change in either the amount of light or heat received, the cycle may proceed continuously without major interruptions. Thus a state of equilibrium is achieved in certain lakes, such that, from one year's end to the next, no great changes in the chemical composition of the water or in the density and character of the flora and fauna are apparent. This state of equilibrium, which is the product of innumerable biological processes, may be likened to a rapidly revolving wheel which seems to be stationary. As with the wheel, so any interference with the biological cycle may produce a disturbing effect. Man by his efforts to catch more fish may cause such an interference and, as will be explained, may cause a slowing down of the whole biological cycle.

Having discussed in general terms some of the principles of fishery research as applied to tropical inland waters, we can now consider some recent findings in greater detail and in more specific terms.

Chemical analyses of the surface waters of all the East African lakes examined have shown that they contain in solution only traces of certain essential plant nutrients. This indicates that plant growth is controlled by the availability of nutrients which are in short supply; in different lakes different nutrients may constitute this limiting factor. This assumption can be tested in the laboratory by growing cultures of algæ in the lake water and finding out whether the addition of certain chemical substances leads to further growth. These experiments have to be carried out under rigidly controlled conditions and in cultures free from bacteria and fungi. This method of testing the water for chemical deficiencies has only recently been developed and is already yielding valuable results. In temperate lakes it has not been found necessary to use this technique for determining chemical deficiencies as, under the varying seasonal conditions obtaining, algal growth is not continuous and variations in the growth of the plankton can be correlated with variations in the chemical composition of the water. It is not possible to do this in the majority of tropical lakes, where algal growth is not interrupted by external seasonal changes.

By using these algal cultures to determine chemical deficiencies, it has been found that lack of nitrates is a factor commonly limiting the growth of the plankton in some of the East African lakes. It may constitute either a primary or a secondary deficiency. The waters of Lake Victoria are deficient with regard to both sulphates and nitrates. This discovery that lack of sulphates may limit the growth of the plankton is surprising, as sulphates have not before been recorded as a limiting factor in inland waters; in fact most waters outside of Africa contain considerable quantities of sulphates in solution. Both plant and animal proteins contain sulphur, so the importance of an adequate supply of sulphates is obvious. It appears that the sulphate content of many African rivers and lakes is critically low, and there is also evidence to suggest that the productivity of some African soils is limited by the amount of sulphate present.

Different species of algæ need different concentrations of the various essential nutrients for satisfactory growth. So a given sample of water may be suitable for certain species of algæ but not so suitable for other species. Because of this the phytoplankton of different lakes is made up of different proportions of the different species and groups of algæ; the dominant algæ in some being diatoms, in others desmids or green algæ, or blue-green algæ in others. Many species of this last group can grow in water containing no nitrates, as they have the ability to fix free nitrogen in solution. Moreover, they secrete considerable quantities of combined nitrogen in the form of polypeptides; they seem to play in freshwaters a role similar to that played in the soil by leguminous plants. They occur in the plankton of all the East African lakes, but are much more abundant in some than in others. Their presence in any lake would seem at first sight to be advantageous, but several points about them need to be considered before a true estimate can be made of the part they play in the general economy of a lake. Besides fixing nitrogen it must be remembered that they are utilizing other plant nutrients some of which may be in short supply. So although they may be increasing the fertility of the water as regards nitrogenous substances, they may at the same time be restricting the growth of other species of algæ more useful than they are as food for fish and other animals.

In Lake Kijanibolola and some other lakes, which are remarkable for the immense quantity of blue-green algæ in the plankton, the *Tilapia*, feeding on this plankton, only grow to a small size. Research has showed that blue-green algæ can pass right through the gut of both *T. esculenta* and *T. nilotica* without being digested; such blue-green algæ must therefore be considered to be of little or no food value. It seems that diatoms are the algæ most readily digested by these fish.

The growth of diatoms may, by a purely physical process, be restricted by the presence of blue-green algæ. Blue-green algæ are very buoyant and characteristically float very close to the surface, where they may form the well-known bloom on the water. Diatoms with their siliceous frustules are not nearly so buoyant, in fact many species tend to sink slowly and are kept in the surface layers of a lake mainly by upward moving currents. A dense growth of blue-green algæ established in the surface waters of a lake can absorb practically all the available sunlight and so almost prevent the growth of diatoms. Viewed in the light of these data it seems that blue-green algæ in spite of their ability to fix nitrogen cannot always be considered advantageous to fishing interests, particularly if their growth is excessive, first because under certain conditions they do not form a satisfactory food for fish, and secondly because they may restrict the growth of other algæ.

Data collected from Lake Rudolf has however added a further complication regarding the value or otherwise of blue-green algæ. In this lake *T. nilotica* feeds on and digests blue-green algæ, and furthermore grows to a great size weighing 10 lb. or more. Investigations are being carried out in order to discover why *T. nilotica* can digest the blue-green algæ in Lake Rudolf, whereas the same species of fish cannot digest the blue-green algæ in Lake George. Results from laboratory experiments indicate that the digestibility or otherwise of blue-green algæ may be determined by the relative amounts of sodium and calcium present in the water.

These investigations on the growth of phytoplankton, apart from providing some explanation for the different density of the fish populations in the different East African lakes, will have a very definite application regarding the proper management of dams and fish farms, in which the volume of water is not great and where it may be feasible to add fertilizers in order to increase their fertility. According to the present state of our knowledge it seems desirable to aim at increasing the fertility of such waters in either of two directions depending on the nature of the water; either to treat the water so as to encourage the growth of diatoms or, if the water is of the type which favours the growth of blue-green algæ, treat it so as to render these algæ more digestible.

The part played by the invertebrate fauna in the biological economy of a lake is immense; these animals, snails, crustacæ and insects, for the most part feed on algæ and are themselves preyed on by fish. Each of these groups of animals is represented in the East African lakes by very many species, the life history and ecological relationships of any one, if fully known, would provide a story of great interest. However, as yet we know very little about them and can for the most part indicate their importance only in general terms.

Snails, besides being an important source of food for many kinds of fish, are vectors of bilharzia in man and liver fluke in cattle. They also act as intermediate hosts to a number of fish parasites. Further knowledge is being gained on which species are vectors of these various diseases and which species of fish feed on these snails. It is advisable to introduce snail-eating fish into dams and fish farms in order to reduce the numbers of snails and so assist in the control of bilharzia and liver fluke.

Crustacæ are the principal animals found in the zooplankton, as such they form the food of a number of fish, notably the "dagaa", two small species of pelagic fish which are the basis of the most important commercial fishery in Lake Tanganyika. The "dagaa" are also the main food of the Nile perch in that lake.

Among insects the Chironomidæ (Lake fly) are almost certainly the most important from the point of view of fisheries. The larvæ of these insects are eaten by many kinds of fish, particularly by the young of predatory fish. They also form the main food of many species of fish throughout their lives. A notable example is *Mormyrus kannume* (the elephant snout fish), which occurs in vast numbers in Lake Victoria and is found in moderately deep water where the bottom deposits are composed of soft mud.

Reckoned by weight they may be the most abundant fish in the lake and their food is composed almost exclusively of the mud-living larvæ of several species of Chironomid flies. Investigations have been carried out on these flies and it is interesting to note that the numbers of these larvæ present in the mud fluctuate in a fairly regular manner. The larval life of these insects is approximately two months and hatches of adult insects occur roughly every month. These insects thus appear to be divided into two temporarily distinct populations, each of these populations consists of several species of these insects. Entomologically this is very interesting and somewhat unexpected as one might have imagined that under tropical conditions all stages of these insects would have been present in the mud at the same time throughout the year. However, from the fishery point of view, it suffices to say that very large numbers of these larvæ are present in the mud and that these numbers do show periodic fluctuations. It has yet to be discovered whether these short period fluctuations have any appreciable effect on the growth rate of these fish. Unlike *Tilapia* spp., *Mormyrus kannume* continues to increase considerably in size after reaching the sexually mature state. There may be several reasons for this, but the fact that this fish has only one breeding season a year may be the most important.

After reaching the sexually mature state *Tilapia* spp., and many other species of fish living in tropical fresh waters, show a marked decrease in their growth rate. This is almost certainly due to the fact that they spawn at frequent intervals. A reduction in growth rate is only to be expected, because for a given intake of food a fish cannot produce ova and milt almost continuously and at the same time maintain a rate of growth comparable with that maintained when immature.

The breeding and brooding habits of *Tilapia* do not allow them to feed normally for long periods; this causes a reduction in their actual uptake of food, thus providing another reason for the reduction in growth rate. The male fish when ripe builds the nest in which the eggs are laid and during the spawning period, which may be protracted, does little feeding. The female fish takes the fertilized ova from the nest and carries them in her mouth where they hatch; she continues to carry the young fish in her mouth for several weeks. During this period she can take little food. Thus the attainment of a large size is, among *Tilapia* spp., determined largely by the growth achieved before they reach the sexually mature state. It is not possible to say definitely at what age these fish become sexually mature, as the time taken appears to vary under different conditions. Evidence exists to show that in some cases they may reach sexual maturity at a very small size in as little as six months. Under other conditions they may take nearly three years to reach the adult state. In tropical waters, where there are no marked seasons, it is not possible to determine the age of fish by reading the scales as is commonly practised in temperate regions.

The age of fish can therefore only be determined, either from data collected from fish farms where fish are introduced at a known size and age and subsequently caught again after a known interval of time, or by marking experiments carried out in natural waters. The latter method is, of course, the more satisfactory as it provides knowledge of the growth rate under natural conditions, whereas data on the growth rate from fish in ponds is an expression of conditions obtaining in that particular pond, and this information may bear little relation to what happens in natural waters and in the larger lakes.

We are particularly indebted to the Lake Victoria Fisheries Service, whose headquarters are at Kisumu, for starting an intensive programme of marking *Tilapia* in the Kavirondo Gulf. Many fish have been recaptured and evidence is accumulating concerning the movements of these fish. One or two fish, with the devil behind them, have been recaptured after travelling about a hundred miles since they were marked. Already some most useful information has been gained from this marking experiment on the growth rate of these fish.

The Lake Victoria Fisheries Service also provide us with invaluable data on the numbers and kinds of fish caught by the African fishermen. There are on Lake Victoria approximately 35,000 fishermen who catch each year about 80,000 tons of fish. These figures are surprising, especially to those who have doubts on the value of inland fisheries or to those who find it difficult to buy fish for the table.

After this diversion into the activities of the Lake Victoria Fisheries Service we must revert to the family history of the *Tilapia*. When brooding their young, *Tilapia* retire to sheltered waters, usually into open swamps containing reeds and water lilies. The dense papyrus swamps, which cover so much of the coastline of many of the East African lakes, do not form a suitable habitat for fish as the water in these swamps is de-oxygenated and contains considerable quantities of dissolved carbon dioxide. There would thus seem to be only limited areas suitable for the *Tilapia* while brooding their young. These brooding grounds, as distinct from breeding grounds, also form the nurseries for the young fish after they leave the parents' mouth until they reach a length of from 7 c.m. to 12 cm. The extent of these swamps and their proximity to the feeding grounds are important factors determining the number of fish in the lakes of East Africa. After leaving the swamps the growth of the young fish is determined, as previously explained, by the amount and digestibility of the food available. This, in turn, is determined by the fertility of the water.

Under tropical conditions fertility is determined by the rate at which nutrients are brought into solution. In the East African lakes where inflows are small relative to the volume of the lakes, the current supply of nutrients is derived mainly from the bottom deposits. Therefore the rate at which these deposits decompose determines fertility. Vegetable detritus decomposes slowly, whereas animal matter decomposes rapidly; it is therefore very desirable that as much vegetable matter, both higher plants and algæ, be eaten and converted into animal matter as possible. We therefore reach the seemingly paradoxical conclusion that up to a point the more herbivorous animals there are living in a tropical lake the more animals that lake will be able to support. All herbivorous animals, whether they are shrimps, snails, insect larvæ, fish or hippopotami, must be considered as agents assisting in maintaining the fertility of the water. If the numbers of these animals were to be reduced for any reason, a higher proportion of plant material would be deposited on the bottom. Much of this material would not decompose before being overlaid by fresh deposits with the result that a gradual reduction in the quantity of nutrients in circulation would occur and this would lead to a gradual reduction in the standing crop of phytoplankton.

When considering the development of any fishery in natural waters it is therefore desirable to attempt to assess the probable effect on the herbivorous animals. In cases where the principal fishery is based on the capture of predatory fish, no serious deterioration of the inherent fertility of the lake need be anticipated, but in those cases where the fishery is based on the capture of herbivorous fish special consideration should be given to the need to maintain a considerable density of these fish. Excessive exploitation may lead not only to a reduction of existing stocks of fish, but also to a reduction in the fertility of the water in which they live.

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THE RHODESIAN RIDGEBACK

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(Received for publication on 30th November, 1953)

In Rhodesia a breed of hounds has been evolved which is characterized by the peculiar lay of the hair along the spine from near the point between the shoulders to a point near the butt of the tail. The Rhodesian Ridgeback or Lion Dog, as it is called, is a strong, powerful hound with a large broad skull, deep muzzle, well-defined stop, moderately long pendulous ears, powerful neck, deep wide chest, sturdy body, strong well-muscled hindquarters, straight legs, and a fairly long thick tail carried low. It is a short-coated animal devoid of any feathering, distinguished by the "cowlick" forming either a fiddle-shaped ridge or a razor back. Many specimens are furnished with well-developed manes (Hubbard, 1946). The dense sleek glossy coat, harsh and waterproof, may be fawn, dark tan, brindle, tawny, or of other main colours, interspersed with white. The Rhodesian Ridgeback reaches a height of 26 in. at the shoulder, and a weight of up to 70 lb. The females are somewhat smaller than the males.

Rhodesian Ridgebacks. After Lloyd

The breed owes its existence to a cross of the original hunting and watch dogs of the Cape Boers, introduced into Rhodesia by mining prospectors, transport riders and hunters, with mastiffs and hounds, possibly retrievers, brought over from Europe (Lloyd, 1937). Some authorities believe it to have developed by a series of crossings between native hunting dogs and the modern bloodhound (Young, 1944).

Young Ridgeback Bitch. From "Hutchinson's Dog Encyclopædia

The ridgeback feature seems to have been imparted to the breed by Boerhounds many of which carried this factor. *The Farmers' Weekly*, Bloemfontein, of 2nd November, 1938, mentions a letter addressed by Mr. F. E. B. Bedford, of Crawford, to the *Cape Times*, discussing the origin of the Ridgeback. Mr. Bedford says that he saw the first dogs with ridges on their backs on the family's farm "Beestkraal" at Hanover about 1887–88 when he was a boy. His father, like nearly every farmer, kept steekbaard (stickbeard) or vuilbaard (dirty-beard) -honde, about the size of greyhounds, dirty-white in colour, very vicious, good runners and fighters. But these dogs had no ridge on their backs. The first ridge dogs were a litter of pups born on Mr. Bedford's farm of a purebred English bulldog bitch by a steekbaard sire. These pups all had the strange ridge of hair along the back. The steekbaard dog that fathered them was a descendant of steekbaard dogs brought from Swellendam by Mr. Bedford's great-grandfather, H. van Zyl, when the trek to the Colesberg district took place.

Gwatkin (1933–34) records a number of letters giving information on the origin of the Ridgeback. A resident in the Northern Transvaal writes: "In the northern parts of the Bushveld, along the Palala and Pongola rivers, about fifteen years ago, quite a number of the original settlers had these dogs. The Burkes, van Vuurens, van Ecks, and Viviers were some of the names mentioned to me". Another correspondent stated that about the time of the Boer War he first saw Ridgebacks in the possession of Jacob Coetzee, a postcart contractor between Dordrecht and Jamestown, C.P. Mr. A. Giese, of Wankie, pegger of the Wankie Colliery and one of the pioneers of Rhodesia, gave information that he knew these dogs along the Crocodile River in 1889, but he did not see one in Rhodesia until 1910. He also stated that the hunter, van Rooyen, always had some of these dogs with him. The most conclusive proof that the Ridgeback originally came from the Cape is furnished by Mrs. Lovemore of Rhodesia who writes: "In 1875 my parents (Rev. Charles and Mrs. Helm) trekked by wagon up from Swellendam to Bulawayo. On their way up someone gave them a pair of dogs with a ridge down their backs. I remember, as a child, having these dogs, and later on, when Mr. van Rooyen went on his hunting trips, he used to borrow some from us and he found them very brave when hunting lions and leopards. About twenty years ago, Mr. Selmes, Mining Commissioner, imported a dog with a ridge and a short tail from Ceres district".

The Ridgebacks brought from the Cape to Rhodesia must not be thought identical in type with the modern Ridgebacks. The original Ridgeback has been crossed, standardized and improved out of all recognition. But the reversed trend of the spinal hair has remained the standard feature of the breed.

This peculiar factor carried by the steekbaard-honde of the Cape Boers seems to go back to a domestic breed of dogs indigenous to South Africa at the time the Dutch East India Company founded its first settlements at the Cape. Mr. F. E. B. Bedford in his above-quoted letter to the *Cape Times* states that his father was told by his great-grandfather that the steekbaard was a cross between a Russian hound and a greyhound. But this theory has no foundation. There is a significant passage in Theal's (1910) description of the domestic dog of the Hottentots: "He was an ugly creature", Theal writes, "his body being shaped like that of a jackal, and the hair on his spine being turned forward, but he was a faithful and serviceable animal of his kind".

Korah Hottentots preparing to move. After Samuel Daniell

In the early days of the European settlement at the Cape the Boers were very keen on acquiring cattle and sheep from the Hottentot tribes, organizing numerous expeditions into the interior for this purpose. There are no records that they showed any particular liking for the Hottentots' dogs as well. But since the Boers got their cattle and sheep from the Hottentots, and as both their steekbaard dogs and the domestic dogs of the Hottentots carried the ridgeback factor, which is a very rare feature, we may assume that not only cattle and sheep but also dogs—the Hottentots possessed no other than these three domestic animals—occasionally passed into the hands of European farmers.

The Hottentot dog, through lack of interest or perhaps open hostility on the part of the early settlers, is now completely extinct, and no skeletal material of it exists in any museum. Whereas with the likewise extinct Hottentot cattle we have at least their descendants, the Afrikander breed, for study and comparison, the Rhodesian Ridgeback, though partly descended from the Hottentot dog and preserving its most characteristic feature, cannot be taken to fill this place, for as Gwatkin (1933–34) states: "The Rhodesian Ridgeback has undoubtedly been crossed with other breeds introduced by Europeans and certainly in a most haphazard manner".

The means of arriving at a sufficiently well-founded theory on the origin and descent of the Hottentot dog are therefore limited to the conclusions that may be drawn from the existing pictures of these dogs, as a painting by Samuel Daniell (1804–05), and from the descriptions by Theal and others. Since the Hottentots themselves appear to have originated somewhere between the lake district of central East Africa and the highlands of Abyssinia, in the same region where they acquired their cattle and sheep, it is reasonable to assume that they came into possession of their dogs in the same place. The descriptions and pictures of the Hottentot dogs show that they belonged to the pariah type, possibly with a strain of greyhound blood carried southwards from East Africa, or bred on slender lines similar to the dogs of the Kalahari Bechuana.

Schlettwein (1914) describes the Hottentot dog as a particularly useful breed, hunting not by scent but by sight. "One can see at a glance", he writes, "that these dogs are descended from greyhounds." Meyners d'Estrey (1891), while praising its courage and devotion as a watchdog, refers to the Hottentot dog as one of the ugliest members of the canine family, with rough bristling hair, dirty-grey in colour, a pointed muzzle, prick-ears and broad feet. Schinz (1891) describes the dogs of the Hottentots as of medium size, with short hair, long snouts, and drooping ears; Von François (1896) as coarse and ugly, and varying in size and colour; while others refer to them as lean hungry-looking mongrels, half starved and savage tempered. Similar descriptions are given by Andersson (1856) and Fritsch (1868) both of whom describe the Hottentot dogs as half-starved mongrels with the ribs sticking out of the skin.

The ridgeback feature has given rise to a strange theory on the origin of the Hottentot dog. Gwatkin (1933–34) has discovered that the latter is not the only breed with the hair on the spine bristling forward, but that it shares this peculiarity with a dog from the small island of Phu-Quoc in the Indo-China seas. This dog is described as follows: "A long head with powerful jaws, erect ears, reddish eyes, with a savage expression, somewhat coarse body, neck very long and flexible, shoulders sloping, belly drawn up, loins broad and strong. Straight and lean legs, stifles rather straight with muscular thighs, longish feet with hard pads. Coat, on the whole body and legs, very short and dense, on the back the hair is growing the wrong way, towards the head, and is much longer and harder. Colour, reddish fawn with black muzzle, the hair on the back being darker. Height about twenty-one inches, weight about forty pounds".

In the absence of an osteological analysis of the Phu-Quoc dog's skull, the description points to a typical southern Asiatic pariah, but distinct in the character of its coat, the hair along the spinal column growing forward. From the similarity of this feature in the Hottentot and the Phu-Quoc dog, Gwatkin argues that "the Hottentot dog, if not actually the same as the Phu-Quoc, is definitely derived from the same Asiatic stock that originated the Phu-Quoc".

While the statement that the African and southern Asiatic pariahs are descended from the same wild stock may be correct, Gwatkin's argument does not prove it. For had the Hottentot or the Phu-Quoc dog the hair on the back lying normal, this would not contradict the theory of their monophyletic origin. On the other hand, the similarity of the ridgeback feature in the Hottentot and Phu-Quoc breeds provides no support whatever for this theory. The range of hereditary variations occurring under domestication is limited, even different species and genera showing parallel variations. These may be brought out under domestication by the same or different circumstances. In the case of the ridgeback feature in the Hottentot and Phu-Quoc dogs a contributory factor may be found in close inbreeding, as both breeds are insular forms, as it were, the Hottentot dog being long removed from the influence of other breeds, since the Hottentots were the southernmost African race of partly Caucasian stock, in a country devoid of people possessed of domestic animals (Epstein, 1937). Under insular conditions the relatively high rate of inbreeding facilitates the issue of mutations, their preservation and propagation.

The parallelism in the character of the coat in the Hottentot and Phu-Quoc dogs proves, therefore, nothing with regard to their genealogy; and it is a fallacy to believe that this variation could not have arisen in Africa spontaneously, but that the Ridgeback, "favourite of the navigating Easterners", must have been introduced by sea from the original home of the Phu-Quoc. Gwatkin goes so far as to state that as the Chinese and other eastern nations were navigating the Indian Ocean for a considerable period before the tenth century A.D., it is from this source doubtless that the Hottentots received their dogs. In support of this theory he even mentions Mongolian characteristics in the Hottentots themselves.

REFERENCES

Andersson, C. J. (1856). Lake Ngami; or Explorations and Discoveries during Four Years' Wanderings in the Wilds of South-western Africa. London.

Daniell, S. (1804-05). African Scenery. London.

Epstein, H. (1937). Animal Husbandry of the Hottentots. Onderstepoort Journal of Veterinary Science and Animal Industry, Vol. 9, No. 2.

Fritsch, G. (1868). Drei Jahre in Suedafrika. Breslau.

Gwatkin, R. D. S. (1933–34). Dogs and Human Migrations. The Journal of the South African Veterinary Medical Association, Vol. IV, Nos. 3/4; Vol. V, No. 1.

Hubbard, C. L. B. (1946). The Observer's Book of Dogs. London and New York.

Lloyd, F. (1937). Hark to the Hounds. The National Geographic Magazine, Vol. LXXII, No. 4. Washington.

Meyners d'Estrey, H. (1891). Les Chiens de l'Afrique Australe. Revue des Sciences Naturelles Appliquées. Nov.

Schinz, H. (1891). Deutsch-Suedwestafrika. Oldenburg und Leipzig.

Schlettwein, C. (1914). Der Farmer in Deutsch-Suedwest-Afrika. Wismar.

Theal, G. M. (1910). History and Ethnography of Africa, south of the Zambesi, before 1795. London.

Von François, H. (1896). Nama und Damara. Deutsch-Suedwestafrika. Magdeburg.

Young, S. P. (1944). Other Working Dogs and the Wild Species. The National Geographic Magazine, Vol. LXXXVI, No. 3. Washington.

CORRIGENDUM

In the article "Stem Borers of Cereal Crops at Kongwa, Tanganyika, 1950–52" by J. C. Duerden, pp. 105–119 of the October, 1953 issue (Vol. XIX, No. 2) the diagrams on pp. 114–119 were inadvertently published in the wrong order and without captions. The following are the figure numbers and captions:—

Page 114, Figure 2.—"Fluctuations in the populations of stem borers in sorghum, 1951."

Page 115, Figure 1.—"Fluctuations in the population of stem borers in maize, 1951."

Page 116, Figure 4.—"Position of borer pupæ in the stem of maize, 1951."

Page 117, Figure 3.—"Position of borer larvæ in the stem of maize, 1951."

Page 118, Figure 5.—"Position of borer larvæ in the stem of sorghum, 1951."

Page 119, Figure 6.—"Position of borer pupæ in the stem of sorghum, 1951."

KIKUYU GRASS

II—An Attempt to Improve a Worn-out Pasture

By H. W. Dougall, Department of Agriculture, Kenya

(*Received for publication on 9th February, 1954*)

Study of a degenerate Kikuyu grass pasture on the South Kinangop showed that the soil is ineffectively aerated, acid in reaction and of extremely low plant nutrient status. It carries on its surface a mat of roots and undecomposed plant residues and unproductive vegetation usually of poor grazing value [1]. To bring about improvement, it is considered that the turf horizon must be broken up mechanically by "ripping" or by ploughing it under, and nutrient deficiencies in the newly aerated soil must be corrected by applying appropriate plant foods. This paper reports the results of attempting to bring these methods of improvement into practical use on Mr. J. F. Lipscomb's farm on the South Kinangop—where the original study was made—and on Mr. R. A. Clay's farm at Elburgon.

Soil Conditions

Analyses of soils taken from two profile sites in the experimental field on the South Kinangop and from one site in the experimental field at Elburgon, are given in Table I. The Elburgon soil is slightly acid in reaction, well supplied with the principal exchangeable-bases, Ca, Mg and K, and percentage saturation of its base-exchange capacity is high. The Kinangop soil is much poorer by comparison and percentage saturation of its base-exchange capacity is relatively low. The carbon: nitrogen ratio for all topsoils is almost identical.

Field Observations

The insufficiently aerated Kinangop soil supports a turf-horizon 2–3 in. thick, composed of matted roots and undecomposed plant residues, but the sward is not as moribund as the degenerate pasture described previously [1]. It produces herbage of high nutritive value over very short periods which, however, is slow to recover after close grazing. The Elburgon soil appears to be better aerated and mat formation is far less evident. Soil conditions here appear to favour a form of decomposition of plant residues which gives rise to a nitrogenous humus and this amorphous material imparts a characteristic brownish-black colour to the topsoil. The sward is never grazed "well down" and whether it is on this account alone, or because of less rigorous climatic and more fertile soil conditions, it seems to have a more erect habit of growth than the closely grazed pasture on the exposed South Kinangop.

Rainfall

From 1st January to the end of September, 1953, only 22.13 in. of rain fell on Elburgon and it was distributed monthly as follows:—

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.
0·77	0·10	1·36	4·50	2·44	5·42	2·82	2·77	1·95

Mr. Clay reported that this rain occurred "in very small falls of little use". During the same period, 26.68 in. fell on the South Kinangop farm and its distribution was:—

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.
0·21	0·71	3·08	7·25	4·95	4·59	1·27	2·59	2·03

Ground frost prevailed during the period January to the end of March, in June, and again in September and October, but the customary cold misty weather of July and August did not recur in this year.

Experimental

The South Kinangop experiment was arranged in two blocks of 15 plots, each 100 ft. long and 30 ft. wide. In each block were three rows of five plots and alternate rows received the following mechanical cultivations—

(*a*) the turf was ploughed out with a mould-board plough and disc ploughed to give an even surface;

(*b*) No cultivation;

(*c*) the turf was ripped repeatedly with a two-gang disc harrow until topsoil became exposed.

Fertilizers were applied as top-dressings to the five plots of each cultivation treatment as follows: sodaphosphate and sulphate of ammonia; superphosphate and sulphate of ammonia; guano and sulphate of ammonia; rock phosphate and sulphate of ammonia. Two ploughed plots and two ripped plots each received lime, superphosphate and sulphate of ammonia; the remaining two plots, which were left uncultivated, received no fertilizers.

Rates of application for fertilizer phosphates were adjusted to provide a dressing equivalent to 54–60 lb. citric-soluble P_2O_5 per acre and fertilizer nitrogen provided the equivalent of 30 lb. N per acre. Lime, containing 47 per cent CaO was applied at a massive rate equivalent to five tons CaO per acre—three times the amount necessary to bring the soil pH to a value of 7 in the laboratory.

The same experimental layout was used at Elburgon but sodaphosphate was omitted from this trial. The fertilizer phosphates and nitrogen applied gave the same amount per acre of citric-soluble P_2O_5 and of N as set out above, but lime was applied at a rate equivalent to ½ ton CaO per acre, this being the approximate amount necessary to shift the soil-reaction value to neutrality.

Results

In the Kinangop experiment the ploughed-out grass reappeared in rows and bore a resemblance to a young cereal crop: ten weeks after mechanical treatment and fertilizer application, all plots were grazed by a dairy herd of 23 head. Immediately before the herd had access to the plots, herbage samples were obtained for chemical analysis, results of which appear in Table II. These data show clearly that ploughing out, fertilizing and allowing natural regeneration produces herbage rich in crude protein and carotene and low in fibre. On the other hand, ripping appears not to affect these components to any extent. The phosphoric oxide content of herbage from ploughed plots is increased by fertilizer phosphorus, especially in the form of sodaphosphate or of guano, and in the presence of nitrogen. The percentage lime content of herbage is largely unaffected by fertilizers except perhaps on ploughed plots where lime and superphosphate are used together with nitrogen.

Plots other than controls received a second dressing of fertilizer nitrogen on 31st July and regrowth herbage was sampled for chemical analysis on 14th September, immediately before again allowing the dairy herd access to the plots. Results of these analyses are shown in Table III.

The herbage from all uncultivated plots contains less protein than corresponding plots which were cultivated, and is slightly more fibrous. For crude protein, the lime, superphosphate and nitrogen treatment fails to maintain the superiority over other treatments which it showed in the first cut, at a time when the control value also was high: indeed, it is markedly lower. The superphosphate and nitrogen treatment also gives a crude protein value inferior to those obtained with sodaphosphate, with guano, or with rock phosphate, and nitrogen. The phosphoric oxide content of all herbage is enhanced markedly by all forms of fertilizer phosphate irrespective of cultivations; in particular the guano and the rock phosphate treatments promote very high P_2O_5 values. The percentage lime content of herbage continues to be improved by the lime applied and values obtained with rock phosphate show that the lime contained in the mineral phosphate is becoming available for plant growth.

In the Elburgon experiment, regeneration following ploughing was slow and on 29th May, ripped and uncultivated plots only were cut and samples taken for analysis, results of which are given in Table IV.

The crude protein values of herbage from cultivated and from uncultivated plots are very little different to that of the control but in the latter, fibre is slightly higher. A gain in carotene is obtained where cultivated plots received guano or superphosphate, together with nitrogen. The phosphoric oxide content of herbage from uncultivated plots is increased by rock phosphate with nitrogen and by guano with nitrogen, and lime, superphosphate and nitrogen promote an increase where plots were cultivated. Rock phosphate markedly increases the calcium content of uncultivated herbage.

In July, plots other than controls received a second dressing of fertilizer nitrogen at the same rates as before, and ploughed plots were cut and sampled for analysis during the second week of August. The data given in Table V show that the herbage is rich in crude protein and carotene, and low in fibre. The phosphoric oxide content of the herbage is at a very satisfactory level, due to all fertilizer phosphates and nitrogen; rock phosphate and guano are slightly less effective than the other forms. The percentage lime content of herbage benefits only from the treatment which includes applied lime.

In September, a heavy concentration of 65 head of mature cows grazed the plots for

2½ days. The animals showed a marked preference for ploughed plots, on which the herbage was greener, and they grazed them down to bare earth. Non-cultivated and ripped plots were grazed not nearly so closely, and material 6–7 in. high was left when the animals were removed.

After defoliation, lack of September rain caused regeneration to be slow, but on 9th October, herbage samples were obtained for chemical analysis (Table VI). Crude protein is highest in the herbage from ploughed plots and least in the herbage from uncultivated plots. There is little difference between all values obtained for crude fibre. The phosphoric oxide content of herbage from uncultivated and from ripped plots benefits from the fertilizer phosphates applied initially, but this is not the case with herbage from ploughed plots, which show no gain in phosphoric oxide over the control. This possibly may be ascribed to the fact that the herbage of ploughed plots, having been severely and closely grazed, is unable to make effective use of soil or residual fertilizer phosphorus in the relative absence of rain.

Discussion

Experience on the South Kinangop and on Elburgon shows that "ripping", to have any effect on mat-destruction or on loosening-up undecomposed plant residues, must be carried out on several occasions. For this reason, such mechanical treatment is unlikely to have practical appeal. Moreover, it is an operation which has to be carried out at times which conflict with other more urgent commitments, such as seed-bed preparation for cereals, which will undoubtedly receive deserved precedence. On the other hand, ploughing offers certainly the quickest and probably the most effective means of attending to mat-destruction and soil aeration, and creating a new and more vigorous sward. It is desirable at the time of ploughing to endeavour to correct known soil deficiencies, especially as regards phosphate, not only for the purpose of replacing losses inevitably occurred by grazing stock, but from the viewpoint of ensuring that a source of the element is available to regenerating herbage. The use of inorganic nitrogen also is to be advocated. If we assume that an acre of soil to plough depth weighs 1,000 tons, then the Elburgon soil contains five tons of nitrogen and the South Kinangop soil three to five tons. Yet, on ploughing, both soils respond to 60 lb. and 30 lb. of nitrogen per acre respectively. It would appear that the nitrogen contained in nitrogenous humus is present in a form not easily assimilable by regenerating herbage, and a quickly available form is necessary.

On the evidence available there seems little to choose between the performance of the different kinds of fertilizer phosphates and for the South Kinangop, provided the aim to put approximately 54 lb. citric-soluble P_2O_5 into the soil is maintained, choice of fertilizer might well be decided on a basis of relative cost per unit of citric-soluble P_2O_5, after due consideration of other factors. For example, in the experiments described, no allowance was made for the calcium contained in rock phosphate, which can amount to 30 per cent of citric-soluble CaO. Results show that at least some of this calcium becomes available to plants, although it is too early yet to say for how long it continues available. Nevertheless, it may be reasonable to postulate that a portion of the calcium contained in rock phosphate is available for absorption into a soil's exchange-complex, and for plant growth. Such calcium, in its capacity as a base, may subscribe to bacterial breakdown of plant residues and other remnants of inverted turf, by neutralizing the acid products of their decomposition. Similarly, for rock phosphate, no allowance was made for the possibility that it might contain more citric-soluble (or available) P_2O_5 than conventional analysis would indicate. Indeed, a single extraction of the phosphate rock with 1 per cent citric acid probably would yield a figure of 4.3 per cent P_2O_5, whereas an additional three extractions of the same sample would yield a further 7.2 per cent of P_2O_5. We may be inclined to agree with Scott-Robertson [2], who, Crowther [3], reminds us, had occasion to describe the citric-acid test as a test for calcium rather than for phosphorus. If the calcium and phosphoric oxide in rock phosphate is shown to be released, albeit slowly, over a period of two to three years or more, there would seem to be a case for advocating the use of the fertilizer, under similar conditions of climate and soil, for permanent grassland and recently established temporary grass.

No allowance was made for the nitrogen contained in the guano fertilizer, and assuming the amount to be 2 per cent, the rate at which this fertilizer was applied would add the equivalent of 9 lb. of nitrogen per acre, or nearly ½ cwt. of sulphate of ammonia.

Superphosphate in these experiments behaved reliably but was not outstanding. Sodaphosphate in the Kinangop experiment was most useful. It is a popular fertilizer on the Kinangop, and almost concurrently with the experiment described, Mr. Lipscomb used it to bring about regeneration of Kikuyu grass on a field scale. He ploughed out an eight-year-old, unproductive paddock and having obtained a tilth, drilled an oat crop with 2 cwt. of sodaphosphate per acre. When the oats were removed for silage, a rejuvenated sward of Kikuyu grass of high feed value had taken their place.

It is injudicious to attempt to judge or to assess the behaviour of lime in all its aspects well within a year of its application, but results from the South Kinangop suggest that one effect is to bring about an increase in the calcium content of the herbage, especially of ploughed plots.

Grazing records, which were kept throughout this first season of the Kinangop experiment, show that the total experimental area carried a beast per acre from the time it was first grazed in June until the end of December. In previous years the same area was used intermittently for grazing which was frequently supplemented with silage.

SUMMARY

A description of an attempt to improve a worn-out Kikuyu grass pasture on the South Kinangop is given. The effect of applying similar treatments to a more or less normal pasture on Elburgon is also described. The use of the plough to destroy mat and undecomposed plant residues is advocated and the correction of plant nutrient deficiencies is recommended.

ACKNOWLEDGMENTS

It is a pleasure again to record the kind co-operation of Mr. J. F. Lipscomb, and his continued interest in this work. Thanks are due also to Mr. R. A. Clay, for allowing a parallel study to be undertaken on his Elburgon farm, and to Dr. H. F. Birch of E.A.A.F.R.O., for analysing the soils.

REFERENCES

[1] Dougall, H. W. *E.A. Agric. J.* Vol. 19, 1953.

[2] Robertson, G. S. *J. Soc. Chem. Ind.*, Lond., *33*, 9, 1914.

[3] Crowther, E. M. *Chem. and Ind.*, pp. 763–766, 1950.

TABLE I.—SOIL ANALYSIS

(Based on air-dry soil)

SOIL		EXCHANGEABLE BASES M.E. PER 100 G. SOIL								pH	P₂O₅ p.p.m.			% Carbon	% Nitrogen	Ratio C:N
	Inches	Ca	Mg	Mn	K	T.E.B.	Ex. H+	B.E.C.	% Sat.		In acid Sol.	Adsorbed	Acid Sol. + Adsorbed.			
Kinangop soil,	0– 2	5·50	3·70	0·405	1·67	11·3	10·6	21·9	51·5	5·6	12	65	309	7·43	0·52	18·9
Kinangop soil,	2– 8	2·85	0·58	0·207	0·88	4·5	14·4	18·9	23·8	5·4	5	27	155	4·84	0·28	22·8
Kinangop soil,	8–16	1·70	0·60	0·390	0·71	3·4	14·6	18·0	18·9	5·2	2	24	114	4·96	0·39	16·7
Kinangop soil,	0– 4	2·13	1·65	0·325	1·08	5·2	11·3	16·5	31·5	5·3	2	20	114	4·05	0·29	18·3
Kinangop soil,	4– 8	2·30	1·06	0·113	0·63	4·1	13·9	18·0	22·7	5·3	5	16	87	4·01	0·26	20·0
Kinangop soil,	8–16	1·13	0·60	0·055	0·68	2·5	8·7	11·2	22·3	5·7	5	5	35	2·16	0·18	16·1
Elburgon soil,	0– 6	14·20	5·60	0·073	4·80	24·7	5·1	29·8	83·0	6·3	35	35	113	8·90	0·63	18·7
Elburgon soil,	6–12	11·70	3·70	0·019	4·45	19·7	3·4	23·1	85·3	6·6	12	16	75	3·30	0·29	14·7

TABLE II.—COMPOSITION OF S. KINANGOP HERBAGE—1ST CUT

(Results based on 100 per cent dry matter)

CONSTITUENT	CULTIVATION	FERTILIZER					
		Sulphate of Ammonia and—					None
		Soda phosphate	Super-phosphate	Guano	Rock phosphate	Lime and Super-phosphate	
Ash	None ..	10·19	10·38	10·85	10·46	—	9·79
	Rip ..	10·31	9·10	8·94	9·81	9·89	—
	Plough ..	9·81	9·46	10·48	11·17	10·61	—
Crude Protein	None ..	14·11	12·39	15·66	12·59	—	16·68
	Rip ..	13·47	13·77	14·93	16·18	17·79	—
	Plough ..	18·96	16·51	19·72	19·57	21·19	—
Ether Extract..	None ..	3·54	3·55	3·65	3·89	—	3·16
	Rip ..	3·65	3·74	3·82	4·02	3·59	—
	Plough ..	3·91	3·50	2·78	3·97	4·22	—
Carbohydrate	None ..	47·59	49·05	46·52	49·84	—	49·70
	Rip ..	47·83	49·10	48·96	46·31	45·22	—
	Plough ..	45·97	49·00	46·68	44·56	43·55	—
Crude Fibre ..	None ..	24·57	24·63	23·32	23·22	—	20·67
	Rip ..	24·74	24·29	23·35	23·68	23·51	—
	Plough ..	21·35	21·53	20·34	20·73	20·43	—
P_2O_5	None ..	0·67	0·64	0·64	0·67	—	0·63
	Rip ..	0·57	0·66	0·69	0·61	0·67	—
	Plough ..	0·83	0·68	0·80	0·64	0·71	—
CaO	None ..	0·72	0·56	0·73	0·79	—	0·69
	Rip ..	0·57	0·56	0·73	0·63	0·69	—
	Plough ..	0·73	0·70	0·62	0·69	0·85	—
Carotene mgm per kilo ..	None ..	253	258	266	220	—	179
	Rip ..	221	253	220	221	262	—
	Plough ..	353	285	305	250	240	—

Table III.—Composition of S. Kinangop Herbage—2nd Cut

(*Results based on* 100 *per cent dry matter*)

Constituent	Cultivation	Fertilizer					
		Sulphate of Ammonia and—					None
		Soda phosphate	Super-phosphate	Guano	Rock phosphate	Lime and Super-phosphate	
Crude Protein	None	17·90	14·32	15·03	15·49	—	14·41
	Rip	19·26	17·75	19·75	19·09	16·13	—
	Plough	21·36	17·83	21·11	18·08	14·71	—
Crude Fibre	None	26·89	27·22	26·81	28·47	—	28·59
	Rip	26·02	25·81	25·17	24·69	26·23	—
	Plough	24·01	25·45	24·78	25·68	24·23	—
P_2O_5	None	0·71	0·95	0·90	1·08	—	0·63
	Rip	0·99	0·86	0·91	1·03	0·79	—
	Plough	0·86	0·84	0·94	1·00	0·86	—
CaO	None	0·65	0·74	0·65	0·88	—	0·66
	Rip	0·70	0·61	0·63	0·83	0·76	—
	Plough	0·63	0·71	0·71	0·73	0·93	—

Table IV.—Composition of Elburgon Herbage—1st Cut (29th May, 1953)

(*Results based on* 100 *per cent dry matter*)

Constituent	Cultivation	Fertilizer				
		Sulphate of Ammonia and—				None
		Super-phosphate	Guano	Rock phosphate	Lime and Super-phosphate	
Ash	None	11·20	12·36	12·33	—	10·84
	Rip	10·70	11·22	11·88	14·06	—
Crude Protein	None	11·48	12·16	11·78	—	10·82
	Rip	11·06	9·91	12·25	12·35	—
Ether Extract	None	2·78	2·89	2·79	—	2·73
	Rip	2·58	3·16	2·90	2·74	—
Carbohydrate	None	49·91	47·43	48·33	—	48·69
	Rip	50·19	49·97	49·43	47·30	—
Crude Fibre	None	24·63	25·16	24·78	—	26·94
	Rip	25·47	25·74	23·55	23·57	—
P_2O_5	None	0·66	0·72	0·83	—	0·66
	Rip	0·66	0·67	0·69	0·80	—
CaO	None	0·69	0·68	0·92	—	0·57
	Rip	0·58	0·64	0·61	0·72	—
Carotene mgm. per kilo	None	182	114	165	—	188
	Rip	238	231	198	187	—

TABLE V.—COMPOSITION OF ELBURGON HERBAGE—1ST CUT (8TH AUGUST, 1953)

(*Results based on* 100 *per cent dry matter*

CONSTITUENT	CULTIVATION	FERTILIZER			
		Sulphate of Ammonia and—			
		Super-phosphate	Guano	Rock phosphate	Lime and Superphosphate
Ash	Plough	11·27	11·06	10·70	10·44
Crude Protein	Plough	21·86	18·79	23·18	24·12
Ether Extract	Plough	4·00	3·74	3·76	3·79
Carbohydrate	Plough	44·47	46·89	43·40	41·98
Crude Fibre	Plough	18·40	19·52	18·96	19·65
P_2O_5	Plough	0·85	0·75	0·77	0·80
CaO	Plough	0·53	0·53	0·54	0·70
Carotene mgm. per kilo	Plough	374	336	279	385

TABLE VI.—COMPOSITION OF ELBURGON HERBAGE—2ND CUT

(*Results based on* 100 *per cent dry matter*)

CONSTITUENT	CULTIVATION	FERTILIZER				
		Sulphate of Ammonia and—				None
		Super-phosphate	Guano	Rock phosphate	Lime and Super-phosphate	
Crude Protein	None	7·49	7·49	7·20	—	6·56
	Rip	8·17	8·84	8·16	9·54	—
	Plough	10·62	10·57	10·22	10·20	—
Crude Fibre	None	28·86	29·82	29·56	—	27·60
	Rip	28·33	29·84	28·43	28·93	—
	Plough	27·89	27·79	28·65	26·52	—
P_2O_5	None	0·56	0·55	0·56	—	0·42
	Rip	0·57	0·49	0·62	0·56	—
	Plough	0·46	0·41	0·41	0·45	—
CaO	None	0·58	0·49	0·59	—	0·52
	Rip	0·43	0·43	0·41	0·46	—
	Plough	0·53	0·49	0·46	0·46	—

THE SELECTION AND BREEDING OF ZEBU CATTLE IN ZANZIBAR

By G. E. Tidbury, Department of Agriculture, Zanzibar

(*Received for publication on 22nd January, 1954*)

The stock farm at the Kizimbani Experiment Station of the Zanzibar Department of Agriculture was established in 1940 by a grant made from Colonial Development and Welfare Funds. The main object of the farm has been to build up an improved strain of Zebu cattle which would possess high milk-yielding capabilities but which would retain the local Zebu's resistance to disease and its ability to thrive on local pasture for the greater part of the year without supplementary feeding. It was necessary also to bear in mind that male animals are commonly used for draught purposes. There has been no attempt to introduce exotic strains into the herd nor to produce the type of grade animals required by the commercial dairymen centred around Zanzibar Town.

The total number of cattle in the Protectorate is about 33,000, of which about 70 per cent are in Pemba Island. The cattle population in Zanzibar, the larger of the two islands, is apparently severely limited by trypanosomiasis (*T. congolense*) transmitted by *Glossina austeni*. Tsetse flies are believed not to exist in Pemba.

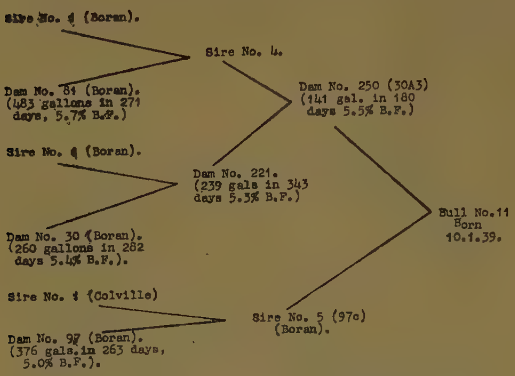
Local Zebu cattle are small neat animals whose height at the hook bones is usually 44 in. or 45 in., rarely exceeding 49 in. or falling below 41 in. The hump is pronounced and the horns usually small and flat. The commonest colours are light red, dun, black and grey: roans and brindles are fairly frequent. There has unquestionably been some admixture of Indian blood in the past and even to-day an Indian appearance is often quite noticeable in individual cattle. Adult healthy bulls weigh about 700 lb. or more and cows perhaps 150 lb. lighter. Heifers come well to the bull at 2¼ years and bulls mature earlier than this. Heat periods are of short duration but little difficulty has been encountered in ensuring regular annual calving provided cows are brought to the bull not later than the second heat after calving.

A good cow, by local standards, will produce about 1,500 lb. of milk in a lactation of one year although it is a common practice to delay weaning in order to lengthen the lactation to well over a year since, if the calf does not suck, the cow may refuse to let down the milk. The foundation animals purchased locally for the Kizimbani herd were chosen for their "milky" appearance and were probably better than average. Half of these animals gave less than 50 gallons in their first lactation and most of the others gave between 100 and 200 gallons. Even when these animals were assessed on their best lactations, a quarter of them were below 50 gallons and the great majority of the remainder between 100 and 250 gallons. It is doubtful whether the admixture of Indian blood has greatly affected milking capacity. The herd now, after 12 years of selection and culling, has assumed a more uniform and typical African Zebu appearance.

The herd was built up from 55 local heifers and young cows purchased during the first few years. Most of these animals came from Pemba and many were quite unused to being handled. They were chosen on appearance and on such evidence as could be had of their dam's good milking qualities.

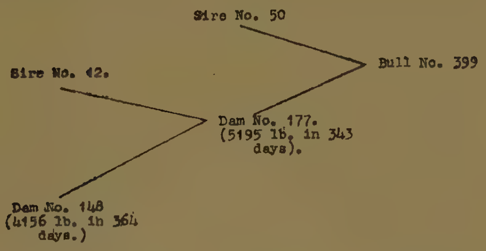
A small nucleus of improved stock was also provided by the purchase of two bulls and six heifers from the Kenya Veterinary Department herd at Ngong. Here, selection and breeding for two or three generations had already taken place and it was considered that these animals would materially accelerate the improvement of the herd during the early stages of the project and also provide a useful standard by which the performance of local animals could be gauged. The Ngong strain is also pure Zebu, much like the Zanzibar type although the animals are rather larger. The introduction of these Ngong animals, however, met with little success. One of the bulls died from dip poisoning soon after its arrival, two heifers never calved and two were very mediocre performers well below the standard of the best local animals. Only one heifer, No. 42, proved to be outstanding with more than one lactation of over 4,000 lb.

The remaining bull, No. 11, sired almost the whole of the first and much of the second generation. His genetical effect will be examined later in the paper. His own breeding was as follows:—



It is possible that the splendid lactation recorded for his great grand-dam may have influenced his selection. Of his remaining female ancestors, only one rose above mediocrity. The breeding of the bull that died was much to be preferred.

In 1949 another outside bull was purchased, this time from the Ndurumo herd at Rumuruti in northern Kenya. Still of the pure Boran type of Zebu, this animal was somewhat taller than the Ngong cattle. His breeding was:—



(Nos. 12, 50, 177 and 148 are Ndurumo numbers)

The Policy for Breeding and Selection

The three methods of improving milk production are by better management, by selection and by breeding. Indeed, the results of selection and breeding are often masked by poor management, for an animal cannot make the most of its inherent ability if it is badly fed and housed.

At Kizimbani, there was everything to learn about proper management. An examination of the graphs of daily milk production (Fig. 1) shows that, for the first five or six years, performance deteriorated badly from April to September, that is during the cool damp months when biting flies abound. A great part of the improvement effected during the following three years consisted in maintaining high performance during this period by better management. This entailed the provision of suitable byres, a proper ration, improved grazing and more effective control of diseases, particularly trypanosomiasis.

Selection, as far as milk production is concerned, has been systematically carried out by adopting a culling standard which has been gradually raised as the performance of the herd improved. All calves are removed from their dams at birth and bucket fed. This enables all cows to be fully milked out and the entire milk yield to be recorded. At first animals were culled if they failed to produce 100 gallons of milk in their first lactation and this standard was later raised in steps of 25 gallons to 200 gallons. Later it was realized that good animals might be lost to the herd by culling them at such an early stage because nervous heifers, unused to handling, not infrequently give a very low yield in the first lactation but a high yield thereafter. Thus Cow No. 111 gave 37 lb. in her first and 2,931 lb. in her second lactation. A cow is now culled from the herd if both her first and second lactations fall below the culling standard. Her daughters are retained, however, because the value of their sires can be assessed by comparing the lactations of daughters with those of their dams.

Such selection is essentially levelling up from the bottom and raises the herd average by reducing the numbers of poor cows and not by adding to the numbers of good ones. Nevertheless, over a long period, progressive culling in this way has a consolidating and cumulative effect on the genetical standard of the herd as a whole.

The breeding policy has been that of bull-testing. In the early years far too much reliance was placed on the imported Ngong bull but later it became clear that this bull improved the herd genetically to a very limited extent. Since then, bull calves from the best cows have been kept entire and subsequently permitted to serve 30–50 cows. The heifers resulting from these services are being compared with their dams as regards milk production and from these comparisons the worth of each bull is gauged.

The main principle adopted has been not to depart from the African Zebu type. At present there is every indication that improvement can continue and that the type of animal needed can be produced by breeding within the local strain.

RESULTS

Animal Production

The annual average calving interval has been remarkably uniform, the yearly average for ten years being normally two or three weeks less than the 12 months and within limits of 332 and 372 days.

When the individual calving intervals are examined, however, a considerably wider variation is observed. Of the first 283 calving intervals recorded, only 68 per cent were less than one year. 79 per cent fall between 300 and 400 days and constitute a fairly normal distribution of which the mean, 340 days, coincides with the mode. Only two abnormally short calving intervals were observed but a fairly high proportion, 19 per cent, were over 400 days. The recurrence of these very long calving intervals is interesting. A large number are the intervals between first and second calvings, a surprisingly large number of cows being successfully served with some difficulty after their first calf although they breed normally thereafter. Of the remaining long calving intervals a few are the result of illness but several represent idiosyncrasies of individual cows. Thus six out of the seven first calving intervals of Cow No. 42 exceeded 400 days.

Birth weights of calves have been most variable. Eighty-five bull calves averaged 36.1 lb. at birth and varied between 22 and 48 lb. while 83 female calves averaged 34 lb. at birth varying between 19 and 45 lb.

Calf weight partly depends on the age of the cow or on the previous number of pregnancies. Table I provides data on this point.

TABLE I

No. of calves	*Pregnancy*	*Average birth weight lb.*
84	1st	34.5
62	2nd	35.8
42	3rd	38.0
33	4th	36.1
28	5th	36.9
26	6th	37.5
19	7th	34.7
12	8th	37.7
9	9th	35.6
6	10th	34.5
3	11th	33.0
1	12th	30.0

It appears that the first two calves tend to be small, the third to the eighth calves of normal weight, and a sharp decline in birth weight is seen in later calves. This is in close agreement with the findings of Messrs. E. Williams and V. A. Bunge in Uganda*.

The sex ratio for the first 386 calves born was 50.8 per cent male and 49.2 per cent female.

Regular weighing to determine live weight gains is carried out only for calves before weaning. Average live weight gains of unweaned calves are approximately 4.5 lb. per week if in good health enabling bullocks to be weaned at 130 lb. between the 25th and 28th week after birth.

The value of supplementary feeding after weaning was shown in a small experiment in which one group of two carefully balanced groups of weaners was fed a ration of 1½ lb. cassava plus ½ lb. simsim cake from about 42 weeks of age until seven months later. Each group consisted of six calves (two male and four female). The results, which were statistically significant, were:—

TABLE II

	Average initial weight lb.	*Average weight after 7 months lb.*	*Percentage gained*
Group A, receiving supplementary food	125.3	267.6	118
Group B, grazing only	124.5	234.8	87

The weights of bullocks older than ten months as shown in Table III are approximate only and have been estimated from the weights of animals sent to relatively hard conditions off the farm.

TABLE III

Age in months	*Approximate live weight lb.*
10	204
20	256
30	446
40	512
50	561
60	602
70	636
80	666
90	693
100	714
110	737
120	756

The regular decreasing of the weight increments with age is of interest, and Table IV has been compiled from records of the same group of bullocks.

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* Empire Journal of Experimental Agriculture, XX, 78, April, 1952, p. 147.

TABLE IV

Average Live Weight Increment per Month During Preceding Six Months

Age at end of incremental period	*Average live-weight increment*
11–20 months	16.5 lb. per month
21–30 months	12.9 lb. per month
31–40 months	9.6 lb. per month
41–50 months	6.3 lb. per month
51–60 months	2.7 lb. per month

Milk Production

In order to assess milk production for the herd, use is made of a "milk index" which is the average yield of milk in lb. per day for the number of cows under consideration. As a month-to-month picture of the performance of the whole herd it is invaluable.

Daily milk indices for the whole herd for the different months of the first 12 years of the scheme, expressed as averages for three yearly periods, are graphically shown in Fig. 1.

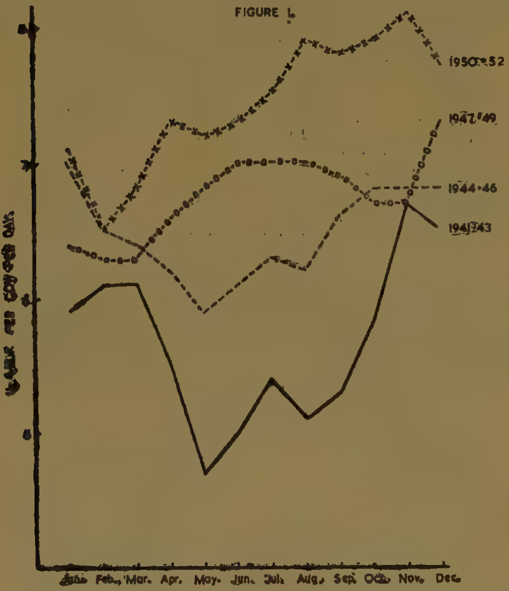


FIGURE 1

Study of this diagram indicates the upward trend of performance over the years. It is clear that the first major improvement was the elimination of the cool-season sag from March to October. This is the least healthy period of the year when rain, cold and biting flies all tend to reduce condition and milk production. In later years, improved management has enabled performance to be kept up throughout the whole year.

Two other methods of assessing the performance of the herd are (i) the average annual output of milk for all the cows in the herd, and (ii) the average of completed lactations during the year, the yield of each lactation being the milk produced in the first 305 days. Both these statistics are in keeping with recommendations made at an informal meeting at the Commonwealth Bureau of Animal Breeding and Genetics at Edinburgh in 1948, and have been adopted in most Commonwealth countries. These figures for the Kizimbani herd are shown graphically in Fig. 2.

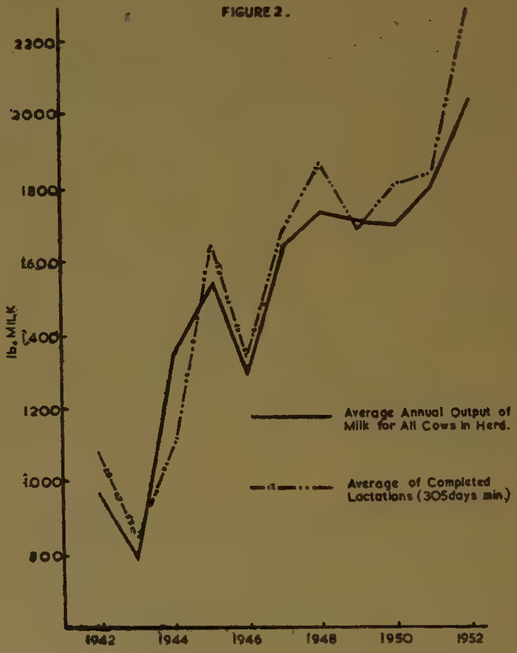


FIGURE 2.

There is obviously a close relationship between these two statistics. The average annual output tends to be lowered if an undue number of dry cows are in the herd at any one time while the average of 305 days' lactations tends to fall if lactations are unduly short.

Apart from the bad year of 1946, progress has been reasonably steady and performance has been approximately doubled in ten years. This is of considerable interest as Dr. N. Wright in his report on cattle-breeding and milk production in Ceylon (Sessional Paper XX of 1946) expresses the hypothesis that an initial herd average of 5 lb. per day can be doubled within ten years and trebled within 20 years. This statement was not intended to represent an actual achievement at that time. In Uganda (E. Williams and V. A. Bunge, *Emp. Jnl. Exp. Ag.*, XX, 78, April, 1952, p. 151) a herd at

Serere in eight years achieved much the same measure of improvement.

There is no doubt that the figures in the above table would have been greatly improved had it been possible to reject individual cows before the completion of the second lactation and to reject their daughters with them. But, in order to have reliable figures on which to base comparisons of the effect of different bulls, it was necessary to retain poor cows longer than would have been tolerated in a purely commercial herd.

It is of interest to record that, on the average, a cow's best lactation has been the fifth, the second best has been the third followed by the fourth and then the second or the sixth.

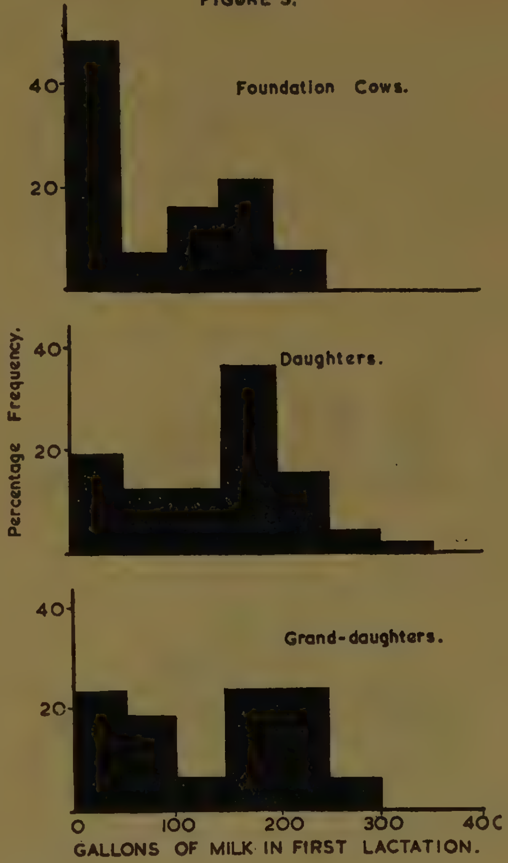
As regards the butter-fat content of the milk produced at Kizimbani, few records have been taken. But records of ghee production provide a useful indication of the richness of the milk. Ghee is produced by the straight cream-to-ghee method of boiling cream which has been ripened for 24 to 36 hours after separation. In 1952 the quantity of ghee produced was 4.6 per cent of the total quantity of milk put through the separator.

Genetic Improvement

The overall improvement in the performance of the herd during the first 12 years was described in the previous section. It is not possible, however, to know how much of the improved performance has been caused by improvements in management for it is certain that better housing, better feeding and more efficient disease control have played a very important part, more important, perhaps, than that played by any inherent genetical changes. The dual effects of better management and of genetical changes, moreover, are not independent. Genetical improvement cannot manifest itself to its best advantage unless environmental conditions are good and unrestrictive. Equally, full advantage cannot be taken of improved environment by animals whose poor genetical constitution is the limiting factor to performance.

To some extent, inherent improvement can be observed from the distributions of the performances of separate generations of cows. Fig. 3 is obtained from the first lactation yields of cows of three generations, viz., foundation cows of local birth, first filial generation, i.e., their daughters, and second filial generation, i.e., granddaughters.

FIGURE 3.



The number of granddaughters are of course too few for serious comparison but there are clear indications of the following trends with succeeding generations—

(i) the high proportion of cows giving very low yields in their first lactation is being reduced with a corresponding increase in the 50–100-gallon group;

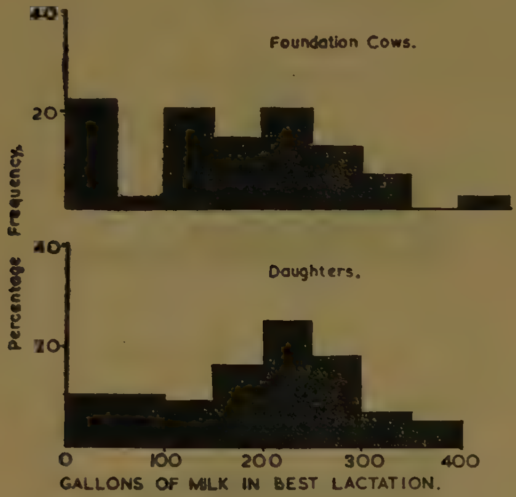
(ii) the mediocre performers, the 100–150-gallon group, are also being decreased with a corresponding increase in the 200–250-gallon group;

(iii) the proportion of high yielders, 250–300 gallons, is steadily increasing.

In order to meet the objection that a comparison of first lactations only is to some extent invalid since first lactations of foundation cows were naturally completed in the early years and those of daughters and granddaughters in recent years when management was better, a comparison of "best" lactations can be made.

This, of course, is subject to the criticisms that the daughters have completed fewer lactations from which to choose and that the first two lactations are very rarely the best. This comparison therefore favours the foundation cows. Too few granddaughters have had more than one lactation, and this generation has therefore been omitted. A comparison between foundation cows and their daughters is shown graphically in Fig. 4.

FIGURE 4.

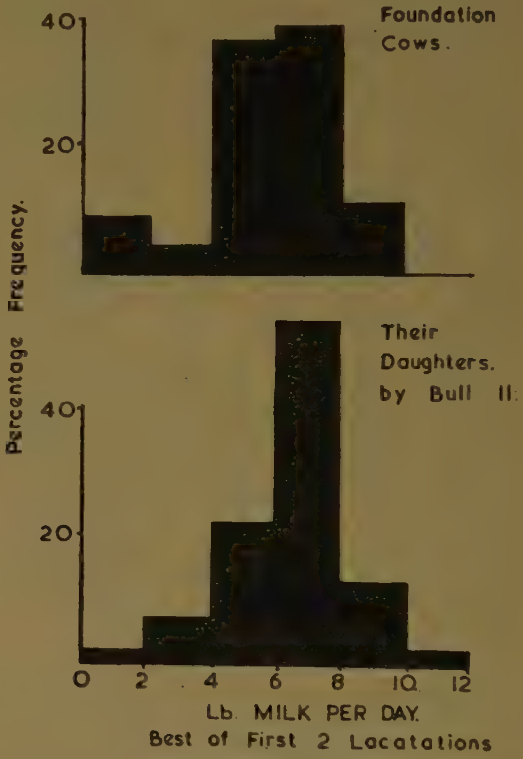


Here, again, can be observed the same effects of shifting a large part of the group of really poor producers into the mediocre group, of raising the proportion of fair performers at the expense of the mediocre and consolidating the proportion of high-performance animals.

The future breeding policy will be formulated on the results of comparisons between the performances of cows and those of their daughters sired by the same bull. In this way the breeding worth of each bull will be assessed. So far only one bull, No. 11, has sired a sufficient number of daughters old enough to have completed two lactations. For this bull some 46 comparisons between dams and daughters can be made on the basis of the better of the first two lactations in all cases.

Twenty-nine of Bull 11's 46 daughters did better than their dams and 17 did worse. He therefore can be said to have caused an overall genetical improvement to the herd. Histograms of the distributions of dams' and daughters' performances are shown in Fig. 5. From this diagram it will be observed that Bull No. 11's main effect on the herd was to eliminate the really poor cows and to bring mediocre performers into the 6–8 lb. per day class.

FIGURE 5.



Extension Work

There is no doubt that the present genetical standard of the Kizimbani herd is already well above that of the unimproved native cattle of the Protectorate. There is virtually no selection of suitable sires for serving local cows, the common practice being to press the nearest cart bull into service. In 1952, therefore, a selection of bulls from Kizimbani was made available in rural areas for stud purposes. It is hoped eventually to have well-bred bulls for service within easy reach of the majority of rural cattle-owners in the Protectorate.

Acknowledgments

I am most grateful to the Director of Agriculture for permission to publish this article and for much help in its preparation. Recognition is also due to several officers of the Zanzibar Department of Agriculture who have, at different times, been in charge of the Stock Farm. In particular the work of Mr. J. Barrett, D.F.C., and of Sheikh Mohamed Hamed el Barwani, is gratefully acknowledged.

A NEW DISEASE OF WHEAT IN KENYA CAUSED BY A SPECIES OF PYRENOPHORA

By A. D. S. Duff, Plant Pathologist, Department of Agriculture, Kenya

(*Received for publication on 15th February*, 1954)

D.C. × Ceres R 64, a popular premium-class wheat selected at Njoro and released in 1953 from departmental control for general cropping, has been attacked by *Pyrenophora tritici-repentis* (Diedicke ex Dreschler) Dreschler (*Helminthosporium tritici-repentis* Diedicke). Samples of infected R 64 were sent in to the laboratory, originally from Londiani (7,600 ft.) in October (a further sample being received on request in November), and from Kipipiri (8,300 ft.) in December, 1953. A third sample which may or may not have been infected was received from Njoro (7,100 ft.) in December. Further samples, both infected and free of disease, were received on request from various farmers in other areas.

Pyrenophora tritici-repentis has been found in various parts of the world, but records are scanty. The main hosts appear to be a species of *Agropyron* and *Elymus*, particularly *Agropyron repens* (L.) Beauv., and it has been reported on these hosts from Britain [1], America [2], Poland [4] and India [9]. It has also been reported as attacking wheat from India [6, 7, 9], in some years severely and in some years in a much milder form, and (apparently) from Japan [5]. It has also been reported from Poland [4] on rye.

FIELD SYMPTOMS AND EFFECTS

Londiani.—A single field had been sown half with R 64 and half with 341. The first sample was received in October when the plants were headed. All the leaves were dead, being a yellow to light brown in colour, with small darker brown areas. The ears were partly filled with small shrunken grains still in the milk stage. The plants were large and the root systems well developed. In December, at harvest, the grains were small and shrivelled. Some were discoloured, and a few showed typical "Black Point" symptoms. Small black perithecia were abundant, being concentrated mainly in the leaf sheaths. Wheat 341 growing alongside was stated to be unaffected. This R 64 crop yielded only three bags per acre as against the average for the rest of the farm of 12 bags.

Kipipiri.—One large field had been planted partly with R 64 and partly with Sabanero. Different areas had been planted with R 64 at different times, though all with the same seed. While all plantings were found to be fairly heavily infected, only one was badly damaged. The farmer stated that this area had been planted while the soil was very wet. Symptoms were slightly different from those of the Londiani crop. It was unfortunate that this crop was seen only at harvest. However, lesions could easily be distinguished on the dead leaves and perithecia were numerous on the leaf sheaths. The plants were smaller than in the neighbouring areas; the stand was thinner though the same seeding rate had been used, patches were laid, and the whole area looked tangled. (*See* plate.) In addition, the roots were badly rotted. In spite of this, the majority of the grains were well filled. There was little discoloration and practically no "Black Point". In this case the yield was five bags to the acre as against an average of ten bags for the rest of the R 64 crop. Adjacent Sabanero plantings were examined in which a trace only of *Pyrenophora* was seen. Rogue plants of Sabanero growing in the infected R 64 crop were also examined. They were lightly infected and the fungus did not appear to be causing them much harm.

A—Diseased. Yield, five bags

B—Lightly attacked. Yield, ten bags

Njoro.—The sample received was very small and was badly overgrown with saprophytes. Immature perithecia were present on the leaf sheaths, and the root were rotted. These plants came from a diseased patch in one field. Isolations failed due to the very heavy covering of saprophytes, but the probability is that the crop was infected with *Pyrenophora.*

The Fungus

Isolation.—A superficial examination of the first Londiani sample showed groups of conidiophores of the *Helminthosporium* type. In moisture chambers, the leaves were quickly overgrown with the usual common saprophytes. Attempts to culture the fungus failed because of this. However, by passing through wheat seedlings and by culturing from the lesions produced, the fungus itself was obtained. Seedlings, at the four-leaf stage, of Kenya Governor and Reliance were used. To these, pieces of the infected leaves of R 64 were attached. The plants were then sprayed with water and enclosed under bell-jars. The plants were kept in the laboratory where the temperature varies from 15° C. to 25° C. and, after two days, the jars and pieces of leaves were removed. Numerous lesions developed on the Reliance seedlings in a further six days. Kenya Governor remained practically free of infection. From these infected Reliance leaves, almost pure cultures of the imperfect form, *Helminthosporium* sp., were easily isolated. Back inoculations from culture to Reliance seedlings proved pathogenicity.

Identity.—The further sample obtained from Londiani bore numerous perithecia on the leaf sheaths. Perithecia from culture were identical. The fungus was then identified as *Pyrenophora tritici-repentis.*

Culture.—At first, the original cultures made on Dox and Malt agars yielded *Helminthosporium tritici-repentis.* After three weeks, perithecial primordia appeared. A fortnight later they were mature. Cultures established from ascospores were slower growing, but also produced *Helminthosporium* and later perithecia. Cultures on agar are, at first, light coloured and somewhat floccose. They become green and later black, when viewed from beneath while from the surface the cultures appear grey with age and contain white floccose sectors.

On sterilized wheat straw, cultures established from helminthospores were the faster growing. Perithecia appeared in three weeks and were mature in a month, while those established from ascospores were about a week later.

Inoculations

Wheat plants could easily be infected using either ascospores or helminthospores as inoculum, though the latter were slightly more effective. After applying the spore suspension made up in water, the plants were kept under bell-jars for two days. Further attempts were made to infect Kenya Governor, with little effect. However, when a piece of agar culture of *Pyrenophora* was smeared on the leaves, lesions were produced; and when smeared round the plants at soil level the plants were quickly killed.

On inoculated plants, the first symptoms seen are small light-coloured areas on the infected leaf. These patches soon turn brown, eventually becoming dark-brown to black with indefinite margins. The lesions are longer than broad and are surrounded by a small chlorotic band, the whole site becoming necrotic with age. Individual lesions are small, being about ¼ in. in length, occasionally extending to ½ in. and are generally ⅛ in. to ¼ in. in width. Several lesions may coalesce, but the darker-brown centres remain discrete. Eventually, the leaves are killed. On mature, nearly dead, plants perithecia are produced.

On plants grown from infected seed, the coleoptiles frequently bear lesions and, in a few cases, the first leaves come up infected. The plants may die of a basal rot.

DISTRIBUTION

The fungus was shown in the laboratory (*see* below) to be seed-borne. Since the disease has appeared twice for certain, and possibly three times, on a wheat just released and grown on a commercial scale for the first season, it was thought that the fungus had been spread in infected seed stocks. Consequently, samples of other crops of R 64 were obtained, some of which had been grown from seed supplied from the same source as the Kipipiri crop and some from other sources. These crops came from many areas: Londiani, Njoro, Gilgil, Kipipiri and North and South Kinangop. All of these crops were found to be infected to a greater or lesser degree. Samples of crops of other commonly grown varieties were then examined. They were obtained from the same areas, excluding Londiani but including Mau Narok. Infection with *Pyrenophora* was frequently found. In some crops infection was moderate, in others a few perithecia were found only after prolonged search, while still others appeared to be free of the fungus. It would thus appear that the disease is present throughout the wheat-growing areas, and has been present for some time. The Senior Research Officer (Plant Breeding) is of the opinion from his own observations that *Pyrenophora* has been attacking wheat for some years and that it has, until now, been passed as *Helminthosporium sativum* P.K. & B.

SUSCEPTIBILITY

There appears to be a varietal susceptibility and resistance within *Triticum vulgare* to *Pyrenophora tritici-repentis*. Observations show that R 64 can be very susceptible while, at the same time, heavily infected crops of that wheat have been seen apparently unharmed. This is shown in Table I

TABLE I

Crop from	Degree of infection	Yield
Londiani ..	heavy	3 bags (bag=200 lb.)
N. Kinangop* ..	moderate	8½ bags
Kipipiri† ..	heavy	12 bags
Kipipiri† ..	heavy	5 bags

* Considered a good crop for the field.

† Two crops growing side by side, one sown under very wet soil conditions and the other dry.

Samples of crops of 318AJ, 294M, 341, Cobbs 1066 and Sabanero have been seen with varying intensities of infection. None of them was severely damaged and pathological symptoms were limited to a few leaf lesions and perithecia. In the laboratory, Reliance is very susceptible, while Kenya Governor is practically immune from spore infection. In India [6] it is stated that the most susceptible varieties were P4 and PIII.

Together with this natural susceptibility it would seem that soil and weather conditions, particularly at planting time, play a very definite role in deciding whether or not a crop shall be damaged. At present, nothing is known as to the conditions predisposing a crop to a damaging attack, except an indication that a very wet seed-bed may do so.

SEED INFECTION

In a preliminary test, 20 unsterilized seed-sized grains from a diseased crop were plated on Malt agar. A further 20 grains were surface-sterilized using alcohol (70 per cent) for ½-minute followed by mercuric chloride (1:1,000) for two minutes. After a thorough washing, the grains were plated out. Of the unsterilized grains, nine did not germinate. Cultures of *Helminthosporium* were obtained from all 20. Two of these, when purified and kept, produced *Pyrenophora*. Sixteen of the sterilized grains germinated and were free of fungus. One other germinated and produced a culture of *Helminthosporium*. The three which did not germinate all produced *Helminthosporium*. It can be seen that all the seed from an infected crop may bear the disease, and that the fungus is carried both internally and externally.

A further test was set up, again using only seed-sized grains. One hundred seeds were used in each of the following treatments to test: (*a*) the effects of the fungus on emergence and subsequent growth of wheat plants grown from infected seed, and (*b*) the value of seed treatments in controlling the disease.

1. Control. No treatment.
2. Alcohol (70 per cent) for ½ minute followed by mercuric chloride (1:1,000) for two minutes.
3. A commercial organo-mercurial seed-dressing. (Agrosan.)
4. Hot-water treatment. Ten minutes at 30° C. followed by ten minutes at 51° C. (This proved rather drastic.)

After treatment, the seeds were planted in greenhouse flats at ½-in. depth. The numbers of seedlings emerging, subsequent growth, and incidence of disease were noted.

TABLE II

AT TWO WEEKS

TREATMENT	Per cent Emergence	Total alive	Per cent of emerging seed alive	Remarks
Control	80	80	100	Coleoptile lesions—53 plants, Leaf lesions—1 plant Plants—thin.
Mercuric Chloride	92	92	100	Coleoptile lesions—13 plants, Leaf lesions—nil, Plants sturdy.
Agrosan	98	98	100	Coleoptile lesions—7 plants, Leaf lesions—nil Plants—sturdy.
Hot Water ..	73*	73	100	Coleoptile lesions—nil, Leaf lesions—nil, Plants—sturdy.

*The hot water treatment has reduced germination.

AT ONE MONTH

TREATMENT	Per cent Emergence	Total alive	Per cent of emerging seed alive	Remarks
Control	80	71	89	9 plants died of basal rot. More foot rot apparent. Leaf lesions—2 plants. Plants thin and straggly.
Mercuric Chloride	92	90	98	2 plants died of basal rot. Leaf lesions—nil. Plants sturdy.
Agrosan	98	97	99	1 plant died of basal rot. Leaf lesions—1 plant. Plants sturdy.
Hot Water ..	73*	73	100	Leaf lesions—nil. Plants sturdy.

*The hot water treatment has reduced germination.

AT TWO MONTHS

TREATMENT	Per cent Emergence	Total alive	Per cent of emerging seed alive	Remarks
Control	80	63	79	8 plants died of basal rot. Leaf lesions—5 plants.
Mercuric Chloride	92	87	95	3 plants died of basal rot. Leaf lesions—1 plant. Plants sturdy.
Agrosan	98	93	95	4 plants died of basal rot. Leaf lesions—2 plants. Plants sturdy.
Hot Water ..	73*	73	100	Leaf lesions—nil. Plants sturdy.

*The hot water treatment has reduced germination.

The germination figures from these two series tests are not in complete agreement, but it has been shown [8] that, except in the case of normally germinating seeds (presumably free of disease), there is poor correlation between tests carried out in dishes in the laboratory and those done in soil. Again, spread of the disease in a stand of wheat in the greenhouse is not strictly comparable to spread in the field where, due to wind and rain, infection of plant from plant would be expected to be faster.

These results demonstrate the value of seed treatment. That the hot-water treatment is best is evident, if it can be carried out in such a way as to avoid killing the seed as well as the fungus. However, under farm conditions and even in the laboratory, without elaborate equipment, this is a very difficult process. Treatment with an organo-mercurial dust, though not eliminating the disease, will certainly reduce it to very small proportions.

In India [3], it was reported that, in "Black Point" grains, mycelium was present within the seed and was not destroyed by seed dressings. While this is undoubtedly true, an examination of the grains from diseased crops showed only a very small proportion of "Black Point". Most of these grains, because of their small size, would never be sown as seed. However, 100 seed-sized "Black Point" grains were selected. Fifty were sown untreated and, though it was not expected that treatment would have any effect, 50 were planted after dressing with an organo-mercurial dust. Emergence was extremely poor, a total of 23 plants appearing above ground, 13 from the treated and ten from the untreated lots. All bore lesions on the coleoptile, and all but seven were dead within a fortnight.

The danger to a crop can thus be seen to be far greater from seed bearing a surface infection (or a mild internal infection) than from "Black Point" grains, few of which grow. Surface-infected seeds grow, produce lesions at and above ground-level, and thus allow the fungus to be seed-borne within the crop. This phase of the disease can easily be reduced to small limits by seed dressings.

SUMMARY

A new disease of wheat in Kenya has been found in crops of DC × Ceres R 64 and other wheats. It has apparently been in Kenya for some time and has probably been confused with *Helminthosporium sativum*. Under certain conditions, it can reduce yields by as much as 75 per cent while other infected crops remain practically unharmed.

There would appear to be varietal differences in susceptibility to the disease.

The fungus is shown to be seed-borne. A good measure of control can be obtained by seed dressings with an organo-mercurial dust.

ACKNOWLEDGMENT

The writer wishes to express his thanks to the Director and staff of the Commonwealth Mycological Institute for identifying the fungus: to Mr. H. C. Thorpe, Senior Research Officer (Plant Breeding) for interest in the work and for obtaining samples of wheat from various growers; and to Mr. W. J. Dawson, Njoro, for bringing in many specimens.

REFERENCES

[1] Dennis, R. W. G., and Wakefield, Elsie M. (1946). New or Interesting British Fungi. Trans. Brit. Mycol. Soc., XXIX, pp. 141–66.

[2] Dickson, J. G. (1947). Diseases of Field Crops, p. 266. McGraw-Hill Book Co., Inc.

[3] Galloway, L. D. (1936, 1937). Report of the Imperial Mycologist. Sci. Rep. Agric. Res. Inst., Pusa, 1934–35, pp. 120–130.

Abst. R.A.M. *16*, pp. 231–32.

[4] Garbowski, L. (1932). Abst. R.A.M. *11*, pp. 694–95.

[5] Ito, S. (1930, 1931). On some new ascigerous stages of the species *Helminthosporium* parasitic on cereals. Pro. Imper. Acad., Tokyo, VI.8, pp. 352–55.

Abst. R.A.M. *10*, pp. 332–33.

[6] McRae, W. (1931, 1932). Report of the Imperial Mycologist. Sci. Rep. Imper. Inst. Agric. Res., Pusa, 1930–31, pp. 73–86.

Abst. R.A.M. *11*, pp. 424–26.

[7] McRae, W. (1931–1934). Report of the Imperial Mycologist. Sci. Rept. Imper. Inst. Agric. Res., Pusa, 1931–32.

pp. 122–140, 1933.

Abst. R.A.M. *13*, pp. 11–13, 1934.

[8] Mead, H. W., Broadfoot, W. C., and Machacek, J. E. (1950). A study of some seed-borne diseases of cereals in Canada. (1) Comparison of seed-testing methods. Sci. Agric. *30*, pp. 350–360.

[9] Mitra, M. (1934, 1935). A leaf spot disease of wheat caused by *Helminthosporium tritici-repentis*. Indian Journ. Agric. Sci. IV, pp. 692–700.

Abst. R.A.M. *14*, pp. 90–91.

E.A. MILK RECORDS OF LEADING COWS—JUNE TO DECEMBER, 1953

By the East Africa Milk Recording Scheme, P.O. Box 478, Nakuru, Kenya

CLASS I (UNDER 2)

Name and Address of Owner 1	Name of Cow and Sire 2	Breed 3		Date of Birth 4	Lactation Records					
					No. of Lactation 5	Calving Dates 6	Milk Yield (lb.) 7	Days 8	B.F. % 9	B.F. (lb.) 10
R. C. Long, Thomson's Falls	Inverurie Flirt 2nd, *Coraville Gold Digger.*	Ayrshire	P	15–10–50	1st	2–10–52	5,625	286	4·37	246
Hafod Estates Ltd., Limuru ..	Canna 2nd, *Preston Supreme.*	„	N.P.	13–12–50	1st	21–11–52	5,312	270	3·85	205
Roderick Lea Ltd., Limuru ..	Kings Vale Linda 157th C.M., A.A.A. *Shepstone Royal Reserve.*	Jersey	P	14–9–50	1st	31–8–52	4,877	262	6·57	320
D. E. Fielden, Subukia ..	Chege 6th, 305, *Unknown.*	„	N.P.	4–8–50	1st	26–7–52	4,205	262	5·25	221

CLASS 2 (UNDER 2½)

Name and Address of Owner	Name of Cow and Sire	Breed		Date of Birth	No. of Lactation	Calving Dates	Milk Yield (lb.)	Days	B.F. %	B.F. (lb.)
Mtarakwa Ltd., S. Kinangop	Mtarakwa Carol 6th, *Benmore Quixote.*	Ayrshire	P	7–6–50	1st	18–11–52	8,319	292	4·17	347
D. Furze, Nakuru	Millie 2nd, *Mtarakwa Barahet.*	„	N.P.	19–7–50	1st	16–9–52	8,365	305	3·83	320
B. R. McKenzie, Nakuru ..	Belvedere Davina, *Oldambster Adam.*	Friesland	P	24–2–50	1st	12–8–52	9,582	305	3·93	376
T. E. Upton, Molo	Hyacinth's Tulip of Mahasu, *Ray Hopes Victory Rose Lad.*	Guernsey	P	14–4–50	1st	13–8–52	6,714	305	4·57	307
Rhodora Estate Ltd., Nakuru	Saburi 70, *Primrose's Rose Lad of Ray.*	„	N.P.	5–7–50	1st	27–7–52	6,721	305	4·07	274
R. A. Clay, Elburgon ..	Trefoil Croix's Poppy, C.M., A. *La Croix Maharajah.*	Jersey	P	1–3–50	1st	4–4–52	6,681	305	5·24	361
D. E. Fielden, Subukia ..	Sabia, 8th, 285, *Mayfield Maharajah.*	„	N.P.	9–4–50	1st	2–10–52	6,807	256	5·98	407

P.—Pedigree. N.P.—Non-pedigree.

CLASS 3 (UNDER 3)

Name and Address of Owner 1	Name of Cow and Sire 2	Breed 3		Date of Birth 4	Lactation Records: No. of Lactation 5	Calving Dates 6	Milk Yield (lb.) 7	Days 8	B.F. % 9	B.F. (lb.) 10
Kabazi Estate Ltd., Nakuru ..	Skerrington Sport 4th, *Brocks Perfection.*	Ayrshire	P	15–12–49	1st	7–11–52	8,456	305	4·33	366
Kivulini Ltd., Molo	Kobe 5, *Mtarakwa Neptune.*	,,	N.P.	25–12–49	1st	28–8–52	6,784	305	4·07	276
B. R. McKenzie, Nakuru ..	Karirana Grilly, A.R., *Oidambster Gysbrecht.*	Friesland	P	21–8–49	1st	15–4–52	11,498	305	4·27	491
W. Prentice, Nakuru	Gladys, *Glenavon Victor.*	,,	N.P.	9–6–49	1st	20–3–52	8,596	305	3·78	325
					2nd	27–2–53	5,424	236	3·63	197
Rhodora Estate Ltd., Nakuru	Maiverley's Beauty 4th, A.R., *Fernhill Roberts Lad 11th.*	Guernsey	P	31–10–48	1st	6–9–51	8,238	305	4·77	393
Mrs. A. R. H. Crompton, S. Kinangop.	Nyagi, *Thala.*	,,	N.P.	11–11–49	1st	23–7–52	5,958	305	4·75	283
Roderick Lea Ltd., Limuru ..	Mornmoot Fancy Starbright 55th, *Selsey Champion's King.*	Jersey	P	10–9–49	1st	28–7–52	6,678	245	4·97	331
D. E. Fielden, Nakuru ..	Mungai 10th, 263, *Oxford Boy of Les Hetres.*	,,	N.P.	6–11–49	1st	17–8–52	5,992	305	6·89	413

CLASS 4 (UNDER 4)

Name and Address of Owner 1	Name of Cow and Sire 2	Breed 3		Date of Birth 4	Lactation Records: No. of Lactation 5	Calving Dates 6	Milk Yield (lb.) 7	Days 8	B.F. % 9	B.F. (lb.) 10
Kabazi Estate Ltd., Nakuru ..	Changue Bellflower 4th, *Willoxton Loadstone.*	Ayrshire	P	24–8–49	1st	24–10–52	9,648	305	3·94	380
Hafod Estate Ltd., Limuru ..	Stella 1st, *Carnekk Man O'war.*	,,	N.P.	20–11–48	1st	10–10–50	7,849	259	3·49	274
					2nd	5–9–51	8,746	314	3·91	342
					3rd	16–9–52	10,751	291	3·60	387
Barclay Estate Ltd., Menengai	Bradwall Emperor's Lorna, *Bradwall Lodge Emperor.*	Friesland	P	8–10–48	1st	17–4–51	10,629	364	3·84	408
					2nd	6–8–52	14,963	305	3·51	525
J. W. Etherington, S. Kinangop	Minata, *Unknown.*	,,	N.P.	7–8–49	1st	2–1–53	9,184	305	3·62	332
Blundell Estate Ltd., Nakuru	Ware Liveley 13th, *Butterpat's Triumph of Ware.*	Guernsey	P	25–2–49	1st	2–6–51	6,807	286	4·36	297
					2nd	30–5–52	11,730	305	4·20	493
S. S. Bastard, Sotik	Mororochi 136, *Unknown.*	,,	N.P.	15–9–48	1st	21–12–50	8,053	305	3·45	278
					2nd	25–4–52	9,691	265	4·00	388
Roderick Lea Ltd., Limuru ..	Travalgan Lady Mint 14th, C.M., A.A.A. *Mornmoot Marchwood Beam.*	Jersey	P	10–8–48	1st	28–12–50	7,688	379	5·82	447
					2nd	6–5–52	6,408	300	5·80	372
R. A. Clay, Elburgon ..	Maharajah's Marion, C.M., A.A.A., *Maharajah of La Commune.*	,,	N.P.	17–4–49	1st	10–5–51	5,208	271	5·98	311
					2nd	24–6–52	8,120	305	5·73	465

P.—Pedigree. N.P.—Non-pedigree.

CLASS 5 (UNDER 5)

Name and Address of Owner 1	Name of Cow and Sire 2	Breed 3	Date of Birth 4	LACTATION RECORDS					
				No. of Lactation 5	Calving Dates 6	Milk Yield (lb.) 7	Days 8	B.F. % 9	B.F. (lb.) 10
Mtarakwa Ltd., S. Kinangop	Mtarakwa Princess, *Benmore Quixote.*	Ayrshire P	5–8–48	1st	22–12–50	8,473	312	4·30	364
				2nd	23–12–51	9,205	289	4·15	382
				3rd	28–11–52	9,165	305	4·31	395
Mr. & Mrs. E. M. Kidner, S. Kinangop.	Marigold 2nd, *Derryfield Mainstay.*	„ N.P.	11–6–48	1st	27–8–50	4,832	283	4·54	219
				2nd	6–9–51	6,016	278	4·35	252
				3rd	9–9–52	7,390	301	4·24	313
B. R. McKenzie, Nakuru ..	Tusogo Prim, A.R., *Oldambster Adema.*	Friesland P	7–6–48	1st	16–5–51	14,328	349	3·66	524
				2nd	30–9–52	12,880	299	3·76	484
Manera Farm Ltd., Naivasha	V 850, *Unknown.*	„ N.P.	15–2–48	1st	13–7–51	5,802	245	3·08	179
				2nd	18–6–52	11,695	305	3·53	413
Olbonata Ltd., Nakuru ..	Olbonata Ruth, A.R., *Ruth's Hero of Whitson.*	Guernsey P	7–3–48	1st	21–12–50	5,223	292	5·13	268
				2nd	3–4–52	7,518	305	5·80	436
Coull Farm, Nakuru	Moiro 3rd, 124, *Caradoc Taragon.*	„ N.P.	23–2–48	1st	14–7–52	8,878	305	4·35	386
R. A. Clay, Elburgon ..	Trefoil Stella's Mignonette, C.M., A.A., *Maharajah of La Commune.*	Jersey P	18–8–48	1st	26–8–50	4,136	263	5·42	224
				2nd	23–7–51	6,266	317	5·71	358
				3rd	4–9–52	8,955	305	5·26	471
D. E. Fielden, Njoro ..	Kongoni 3rd, 186, C.M., A., *Moyeni Designer's Silver Triumph.*	„ N.P.	3–9–47	1st	6–4–50	6,656	305	5·92	394
				2nd	26–5–51	6,151	261	5·30	326
				3rd	19–4–52	7,602	305	5·62	427

CLASS 6 (MATURE)

Name and Address of Owner 1	Name of Cow and Sire 2	Breed 3	Date of Birth 4	No. of Lactation 5	Calving Dates 6	Milk Yield (lb.) 7	Days 8	B.F. % 9	B.F. (lb.) 10
Drinmore Farm, Naivasha ..	Drinmore Janet, *Borgue House Democrat.*	Ayrshire P	17–8–51	1st	2–8–51	11,084	306	3·68	408
				2nd	12–11–52	13,259	305	3·63	481
Lesirko Ltd., Ol'Kalou ..	Lesirko 692, *Kinsman of Kivulini.*	„ N.P.	10–9–44	1st	4–8–49	11,592	418	4·08	470
				2nd	12–12–50	10,491	364	3·82	401
				3rd	24–10–52	9,525	273	3·94	375
B. R. McKenzie, Nakuru ..	Karirana Dainty, *Colonies Plaats Sytche Lodewyk.*	Friesland P	20–5–45	2nd	23–4–50	12,017	317	3·25	391
				3rd	7–3–52	18,291	305	3·27	598
				4th	13–2–53	12,204	277	3·06	373
Manera Farm Ltd., Naivasha	X 115, *Unknown.*	„ N.P.	1943	1st	22–6–50	16,707	313	3·16	528
				2nd	26–7–51	19,858	305	2·66	528
				3rd	5–1–53	17,055	303	3·16	539
Blundell Estate Ltd., Nakuru	Lockinge Lady Belle 32nd, A.R., *Hughenden Lord Richmond 4th.*	Guernsey P	2–3–47	1st	25–4–51	3,486	95	5·15	180
				2nd	5–4–52	11,968	305	4·56	546
				3rd	15–4–53	8,024	208	4·79	384
Spring Farm, Elmenteita ..	Mukiey 2nd, 41, *Kagio Adam.*	„ N.P.	15–1–45	1st	17–1–52	8,520	305	4·85	412
R. A. Clay, Elburgon ..	Osirua Luna, C.M. A.A. O.M. G.M. S.M. *Capricorn of Rosel.*	Jersey P	29–9–52	2nd	22–2–50	10,086	350	5·86	591
				3rd	19–3–51	11,769	305	5·54	652
				4th	29–6–52	10,313	305	5·46	563
D. E. Fielden, Subukia ..	Sabia 2nd, 134, C.M. A.A.A. *Osirua Jupiter.*	„ N.P.	11–3–46	2nd	8–4–50	6,266	324	5·99	375
				3rd	12–5–51	11,619	365	5·22	606
				4th	23–9–52	9,792	305	5·89	577

P.—Pedigree. N.P.—Non-pedigree.

THE PHYSICAL IMPORTANCE OF FOREST COVER IN THE EAST AFRICAN HIGHLANDS

By **H. C. Pereira, E.A. Agriculture and Forestry Research Organization**

(*Received for publication on 27th January,* 1954)

The belief that the presence of large areas of forest may be the direct cause of local rainfall has been widely held since the close of the last century, when scientists, both in Germany and France, reported rainfall readings in forested areas to be higher than those measured in the immediately surrounding arable countryside. With the advance of our knowledge of meteorology, and of the techniques of rainfall measurement, it has become apparent that such effects need very large-scale experimental studies with adequate statistical planning. The complexity, long duration and expense of such studies are illustrated in the reports by Wicht [1] and by Rycroft [2] of the 20 years of forest hydrology measurements in the Union of South Africa. The specific evidence is slender because few countries have had the staff or the foresight to lay down such experiments. Hughes [3] in 1949 briefly surveyed the principal sources of evidence applicable to East Africa, concluding that the effects of forest on rainfall (as apart from local climate) are "not yet proven". Hursh [4] has since published results of a study in Tennessee which is particularly relevant to East Africa, where the resources devoted to such work are still extremely slender. Hursh's evidence is discussed later in this paper.

While studies of the effects of afforestation have only just begun in East Africa, the results on local climate of the large-scale removal of vegetation are unfortunately all too familiar throughout the drier parts of this continent. They have, indeed, been studied by several public commissions, such as the three South African commissions on the advance of the Karoo desert and the international commissions which have studied the Sahara. All have drawn attention to the adverse effects of denuded areas, which heat the air passing above them, and thus spread their influence to surrounding regions. Hursh [5] has drawn attention to the serious deterioration which is occurring in East Africa's extensive semi-arid areas by the operation of these effects.

The catchment areas of East Africa's highlands depend for the effectiveness on the cooling of the air masses flowing across the land. When cooled, moist air can no longer carry its former load of water, the excess condensing as mist or rain. Even when the temporarily unstable conditions caused by the Inter-Tropical Convergence Zone lead to brief rains over large areas of East Africa, the heavier rain still falls on the high ground where the air masses are most effectively cooled. The cooling is due in the main to the lifting of the air mass, but its rapidity is increased by the cool surface conditions provided by a forest cover, and is reduced by the heat reflected upwards from bare soil. In temperate climates the effects of bare soil areas have been reported in text-books of aeronautical meteorology to extend to 3,000 ft. above the land surface [4], while the effect may be greater in the tropics.

Areas in which such effects can be directly tested are rare, but Hursh made use of the conditions created by the large areas of vegetation changes surrounding the copper-smelting industry of the upper Tennessee Valley. Here in 1850 the open-hearth smelting of copper began the destruction of adjacent vegetation, while the felling of trees for fuel assisted in the conversion of large areas of mixed hardwood forest into open grassland. The area of change reached a maximum in 1910, since when there has been some regrowth at the forest edge, and a steadily increasing destruction of the grassland as erosion has spread from the central denuded area. The latter now occupies about 7,000 acres of gullied bare soil, surrounded by a belt from one to two miles wide, and 17,000 acres in extent, of open grassland. The dominant grass is *Andropogon scoparius* L. A 30,000-acre transitional zone of regenerating pine-wood fringes the surrounding indigenous hardwood forest, which once occupied the whole area. Seventeen years of rainfall records show an average of 54 in. per annum, with good distribution, mild winters, and little snow.

The Tennessee Valley Authority placed a gauge at the smelting works in the centre of the area, and the ten-year average for this gauge is the lowest in the district. For closer investigation of these three zones, Dr. Hursh set up six meteorological stations, in each of which a number of climatic factors were autographically recorded.

Soil temperatures at 4½ in. during the growing season were about 20° F. higher in the bare area than in the forest. Maximum soil temperatures at ½ in. depth reached 82° F. in the forest, 105° F. in the grass and 127° F. in the bare zone. These soil temperatures in turn affected the rates of evaporation, the mean open water evaporation rates for four years being: forest, 17.76 in.; grassland, 46.19 in.; and bare soil, 56.95 in. The mean annual rainfall for the four years was: forest, 57.42 in.; grassland, 52.78 in.; and bare soil, 50.30 in., all differences being, statistically, highly significant. While a longer run of years and more rain-gauge stations are required for conclusive proof, the data support the hypothesis advanced by earlier workers that the removal of forest has resulted in a reduction of local rainfall, and a pronounced deterioration in local climate.

For a tropical country such as East Africa, so completely dependent on its very limited catchment areas, the evidence is already sufficient to challenge any large-scale transition from forest to arable as a matter of policy. The general effects of forests on flood control is well known as the result of large-scale catastrophes, and subsequent large-scale experiments, in the U.S.A.

Recent reports from the U.S.A. supply direct measurements of the results of changes in land use of catchment areas. Dils [6] has studied the first ten years of hydrological behaviour of a catchment area in Michigan after the forest was felled in 1941; part of the land was devoted to arable under maize, part to grazing, and part to secondary forest growth. Infiltration decreased on the arable, and decreased more sharply on the grazed land, while the percentage of rainfall lost by surface run-off doubled for the whole catchment area, with marked increases in flood peaks. That the forested slopes should not be heavily grazed is well illustrated by the results obtained by the Coweeta Hydrological Laboratory in the Southern Appalachian Mountains of the U.S.A. Johnson [8] reports that after seven years of preparatory stream-gauging a hill-side catchment area of hardwood forest, on deep permeable soil, was opened to grazing. For the next eight years an average of only six beasts grazed 145 acres of forest and small clearings. By the end of this grazing period the stream-gauge showed peak rates of run-off during heavy storms to be four times the rates registered in the previous seven years. Trampling of the cattle, at only one beast per 24 acres, had seriously decreased the permeability of the forest floor. This extra run-off is, of course, lost to the ground-water reservoirs which supply the essential dry-weather flow of streams on which agriculture in the lower countries depend. The same effect can be seen in the higher parts of the Kikuyu Reserve, where maize and cattle have replaced forest, and annual floods of red soil-laden water have replaced milder fluctuations of clear forest streams.

The initial effect of the felling of large areas of forest is, of course, a great reduction in transpiration with a marked increase in dry-weather stream-flow. The classical Wagon Wheel Gap experiment [8] showed a gain of 12 per cent in dry-season flow by clear-felling a pine forest. Hoover [9] has reported gains in stream-flow equal to the previously estimated transpiration of the forest cover. Hursh [10] reported that after the clear-felling and regrowing of mixed forest species, the young trees were 30 ft. high after nine years, but stream-flow was still 25 per cent above that from the original forest. If a new crop of trees are grown either by plantation or by natural regeneration there is no danger of accelerated erosion, but the infiltration rates of forest soils decline very rapidly with exposure. Hoyt and Troxell [11] reported a 29 per cent increase in stream-flow over the first six years after burning of *chaparral*, but the forest soil deteriorated rapidly, and severe and widespread erosion occurred within that short time. If the trees can be replaced by a stable, shallow-rooted form of vegetation, without cultivation, the result of their removal may be a steady increase in stream-flow, as shown by Monniger and Blain [12], who obtained a saving in transpiration, as measured by soil moisture loss, of over 4 in. per year by removing aspen trees and leaving a herbaceous cover which rooted only to two or three feet.

In East Africa, the weeds and grasses which volunteer after removal of forest are characteristically deep rooted. Direct measurements of these effects by soil moisture studies in a forested catchment area of the Aberdares at 8,700 ft. have been carried out by E.A.A.F.R.O., in co-operation with the Kenya

Forestry Department for the past three years [13]. A cypress plantation was partly clear-felled, and part left for comparison both with the clearing and with adjacent natural bamboo forest. When weed-growth was unchecked, herbaceous species grew rapidly in a test-plot in the clearing to a height of over 4 ft., and in the five dry months from June to November, 1952, removed rather more water from the first 6 ft. of soil than either cypress or bamboo took from the first 10 ft. The remainder of the clearing was kept clean by forest "squatter" labourers, who grew vegetables for one year, followed by tree seedlings interplanted with vegetables in the next year. When weeds in the test area were controlled as for the rest of the clearing there was a saving, measured in the first 6 ft. of soil, of the equivalent of 3 in. of rain in one dry season, followed by a further saving of 3 in. during the rains which followed. This beneficial effect of clearing occurs only while the forest litter is present and the forest itself absent. That this state of affairs is short-lived is well demonstrated by the nearby cultivated clearing of the forest nursery, which has completely lost the water-receptive layer of organic matter created by the forest.

When pasture replaces forest on East African catchment areas, the deep-rooted perennial species such as Star-grass (*Cynodon* spp.) and Kikuyu-grass (*Pennisetum clandestinum*) rapidly dominate the sward. Kikuyu-grass roots have been traced to 19 ft. and measured volumetrically to 15 ft. [13]. A catchment area study of Kikuyu-grass pasture, conducted concurrently with that described above, has shown, by continuous soil moisture sampling to 10 ft., with occasional samples to 15 ft., that this pasture stores and uses by transpiration almost the whole of the annual rainfall. Water use by Star-grass has not yet been measured, but the roots of a rather poor Star-grass sward only three years old were traced recently beyond 12 ft. On the catchment area studied the Kikuyu-grass, skilfully managed, has given no run-off whatever in four years. More heavily stocked pastures have shown so much run-off as to require terracing.

Thus the land-use producing maximum water yield from high-altitude catchment areas which are naturally forested, is to grow on them trees which are felled periodically. After clear-felling, cleaning of the land and immediate replacement by planting of seedling trees, kept clean-weeded until they shade the ground, offers the maximum interruption of transpiration which can be achieved economically and without risk of accelerated erosion. A fear has been expressed that the quick-growing softwood plantations may use up more water than the natural bamboo forest which they displace. The evidence so far obtained by the measurements in the Aberdares already mentioned [13] have shown such fears to be groundless. Even when well-grown, the cypress plantation appeared to have more favourable water effects than did the bamboo, and the more rapidly such plantations grow, the larger the proportion of the total catchment area which will be harvested by clear-felling in any one year. Rycroft [2] reports that a 55-ft.-high plantation of *Pinus radiata* at Jonkershoek Forest Experiment Station near Capetown has used less water, as judged by stream-gauging, than did the original scrub cover of the catchment area.

One effect which has been consistently demonstrated by experiments is the excessive transpiration of water by stream-bank vegetation. (Dunford and Fletcher [14]; Croft [15].) The Forestry Department of South Africa have, since 1932, planted no trees within 60 ft. on either side of streams (Wicht [16]). In East Africa it may eventually become necessary to spend public money on the cutting of scrub trees along stream-banks, although it will first be necessary to establish that the volunteer herbs and grasses which replace the trees will, in fact, use less water.

A forest cover has a final advantage not shared by arable or pasture. Penman [17] has shown that the total transpiration of all continuous vegetation covers, if freely supplied with water, should be approximately equal, since they must depend upon the arrival of solar energy, and on the speed and dryness of the wind. His calculations have been remarkably well substantiated by the prediction of underground water-levels and catchment area yields in England [18]. Thus the extra leaf area of a forest does not result in greater use of water, as compared with pasture grass. When surrounded by the cloud, fog or mist which is normally a feature of high catchment areas, however, the condensation of water and its absorption into the plant depend, not upon the horizontal area exposed to sun and wind, but on total leaf area available for condensation. While striking examples of fog-drip measurements have been reported [19], measurements have not yet been attempted in

East Africa, although it is hoped to begin them shortly. Those who have been soaked to the skin by the heavy fog-drip of an East African forest in the early morning will expect substantial amounts to be measured, but the collection will be difficult, and the sampling must be thorough. The direct absorption of such condensed water by plants is, however, convincingly established by the simple and ingenious experiments of Breazeale and McGeorge [20] who showed that the complete transpiration stream of a plant can be reversed when its foliage is in mist, and that the rate of absorption is directly proportional to the leaf area. Stone, Went and Young [21] have further shown that this occurs in a mountain forest species, the Coulter Pine, which thrives on a very low rainfall in California. These condensation and absorption effects may account for the existence of coastal forests in East Africa, such as the Shimba Hills [22] in which trees characteristic of an 80-in. rainfall flourish on a recorded average of only 45 inches.

In consideration of land-use policy for East Africa's small and vital catchment areas, the economic and hydrological advantages thus lie with a system of combining the physical benefits of a tree cover over most of the area with rotational felling of a portion each year for the safe improvement of stream-flow.

REFERENCES

[1] Wicht, C. L. (1947). Hydrological Research in S.A. Forestry. Brit. Emp. For. Conf., G.B., 1947.

[2] Rycroft, H. B. (1951). Hydrological Research in S.A. Forestry. Commonw. For. Conf., Canada, 1951.

[3] Hughes, J. F. (1949). *Emp. For. Rev.*, *28*, 314–323.

[4] Hursh, C. R. (1948). Local Climate in the Copper Basin of Tennessee as Modified by the Removal of Vegetation. Dep. Circ. U.S. Dep. Agric. No. 774.

Hursh, C. R. (1952). Forest Management in Relation to Climate, Water and Soil Resources. E.A.A.F.R.O. Ann. Rep., 1952, 26.

[6] Dils, R. E. (1953). Changes in Some Vegetation, Surface Soil and Surface Run-off Characteristics of a Watershed, Brought About by Forest Cutting and Subsequent Mountain Farming. *Mich. St. Coll. Diss. Abstr. 13*, 146.

[7] Johnson, E. A. (1952). Effect of Farm Woodland Grazing on Watershed Values in the Southern Appalachian Mountains. *J. For. 50*, 109–113.

[8] Bates, C. G., and Henry, A. J. (1928). Forests and Stream-flow Experiment at Waggon Wheel Gap, Colorado. U.S. Dep. Agric. and Weath. Bur.

[9] Hoover, M. D. (1944). The Effect of Removal of Forest Vegetation upon Water Yields. *Trans. Amer. Geophys. Un.*, *25*, 969–977.

[10] Hursh, C. R. (1951). Research in Forest Stream-flow Relations. *Unasylva, V*, 3–9.

[11] Hoyt, W. C., and Troxell, H. C. 1932). Forests and Stream-flow. *Proc. Amer. Soc. Civ. Engrs.*, *58*, 1057–1066. *See* also *Misc. Publ. U.S. Dep. Agric.*, No. 397, 38, 1940.

[12] Monniger, L. V., and Blain A. (1950). Evapo-transpiration in Relation to Soil Stability and Water Available for Stream-flow. File Report; Intermountain Forest and Range Expt. Station, Utah.

[13] Pereira, H. C. (1953). E.A.A.F.R.O. Annual Report (in press).

[14] Dunford, E. G., and Fletcher, P. W. (1947). Effect of Removal of Stream-bank Vegetation upon Water Yield. *Trans. Amer. Geophys. Un. 28*, 1.

[15] Croft, A. R. (1948). Water Loss by Stream Surface Evaporation and Transpiration by Riparian Vegetation. *Trans. Amer. Geophys. Un.*, *29*, 2.

[16] Wicht, C. L. (1949). Forestry and Water Supplies in South Africa. *Bull. Dep. For. S. Afr.* No. 33.

[17] Penman, H. L. (1948). Natural Evaporation from Open Water, Bare Soil and Grass. *Proc. roy. Soc.* A, *193*, 120-145.

[18] Penman, H. L. (1950). Evaporation Over the British Isles. *Quart. J. R. Met. Soc.*, *76*, 372–383.

[19] Kittredge, J. (1949). (In) Report of Committee on Evaporation and Transpiration. *Trans. Amer. Geophys. Un.*, *30*, 131.

[20] Breazeale, E. L., and McGeorge, W. T. (1953). Exudation Pressure in Tomato Roots. *Soil Sci. 75*, 293–8.

[21] Stone, E. C., Went, F. W., and Young, C. L. (1950). Water Absorption from the Atmosphere by Plants Growing in Dry Soil. *Science 111*, 546–548.

[22] Hursh, C. R., and Pereira, H. C. (1953). Field Moisture Balance in the Shimba Hills, Kenya. *E. Afr. Agrc. J.*, *18*, 139–145.

A NOTE ON DAMAGE TO DURA (SORGHUM VULGARE PERS.) BY HORMONE WEEDKILLERS

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(*Received for publication on* 16*th November*, 1953)

Very few details are to be found in the literature of damage to this crop as a result of treatment with the hormone-type weed-killers. During the past three years, experiments at the Gezira Research Farm in the control of the root parasite *Striga hermonthica* Benth., by means of these weed-killers, have brought to light a number of instances of damage.

In 1952, a year of adequate but not excessive rains, irrigated dura on the Gezira Research Farm was treated at 2, 3, 4 or 5 weeks after sowing, with amounts of sodium 2:4-D ranging from ½ lb. to 2 lb. per acre. The crop when treated was roughly 6 in., 12 in., 18 in. and 24 in. at the respective spraying times. A slight degree of damage, consisting in the partial unrolling of the uppermost leaf sheaths, was noted shortly after the 2- and 3-week sprayings on almost all plots; plots treated at 4 or 5 weeks after sowing showed no damage at any spray strength up to 2 lb. Recovery from this damage was in most cases rapid. A more serious form of damage to the crop from the weed-killer spray, however, took the form of strong bending responses; in some cases the bending caused the tip to press firmly into the ground a few days after spraying. Where these symptoms occurred, the severity increased during the two weeks following spraying, after which recovery or death set in. At this stage, all affected plants were leaning over, although bending had now ceased. (Fig. 1.)

Examination of the affected plants showed that a large proportion of the roots had been killed as a result of the treatment, resulting in a loss of anchorage to the plant. Growth of the aerial part of the plant had however continued, making the plant even more top-heavy. Wind could then complete the process by blowing the plant completely over and severing the remaining roots. The response of the plant lay in the production of new roots, but these, either on account of remaining influence of the 2:4-D or for some morphogenic reason connected with the zone of the stem from which they were formed, were all of the "prop root" type—thick and blunt-pointed. Only after considerable softening of the soil by rain were they able to penetrate at all. Where they did so, the plant recovered; where they did not do so, the plant, eventually reduced to a prostrate stem, wilted and died. (Figs. 2, 3.)

Where satisfactory contact with the soil was regained by the plant, growth was in most cases resumed not from the prostrate original stem, but from tillers at its base, often leaving the original stem still prostrate and without any apparent geotropic response (Fig. 4), though still living. No malformations, such as have been reported for oats and other crops, were to be observed in the heads at harvest time, though as no sprayings were carried out later than 5 weeks after sowing the full range of possible conditions has not been investigated. However, irrigated dura at 5 weeks old, if it has been kept clean from weeds, is well able to suppress any which arise after that time; and dura which has not been weeded until that date is probably incapable of benefiting by the spray. The question of whether later spraying will cause deformed heads is thus purely theoretical.

The effect of pre-emergence sprayings is to cause the crop to fail to emerge.

The season 1952 was a favourable one in that growing conditions for the crop were excellent, and under no rate or time of treatment was there a sufficient kill of the crop to affect the final yield of grain. In 1951, however, a crop 2 weeks old, sprayed at a time when much of it was suffering from thirst, was so heavily damaged that the experiment had to be abandoned. In 1953 a crop of similar age sprayed when still wet from irrigation, received over 80 mm. of rain during the following two days, with again a serious reduction of stand. On the other hand, another part of the same field was not sprayed until a week later, when it had drained and dried somewhat; damage symptoms occurred but recovery was rapid.

It seems that for avoidance of spray damage to dura on the irrigated heavy clays of the Gezira, the following precautions should be observed:—

(1) Spraying should not normally be carried out earlier than 2 weeks after sowing.

(2) Strength higher than 1 lb. per acre should not normally be used.

(3) Spraying should be carried out when the soil is neither so dry that the plant is suffering from thirst, nor so wet that there is danger of water-logging if rain follows the spraying.

It also seems probable that deeply sown dura is at an advantage for it has been noticed with hand-sown dura that one row may show extensive damage, whereas a neighbouring row, sown by a different member of the team, may show little or none. This has doubtless to do with the dilution of the chemical in the soil before it reaches the plant roots.

Once the damage has occurred, very little can be done, except perhaps in the case of the odd few plants which are struggling to re-establish their root systems. A man with a digging tool can cover the exposed plant-bases and protect them from the sun; this will also keep the soil round the new roots in a moister and softer condition, allowing easier penetration. It is, however, felt that the observance of the above precautions should prevent most of the more serious forms of damage.

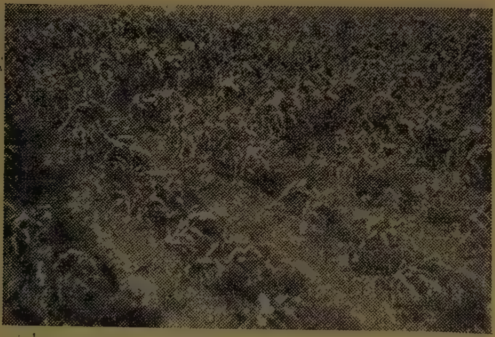


Fig. 1—Dura damaged by 1 lb./acre sodium 2: 4-D, 35 days after sowing, 21 days after sraying.

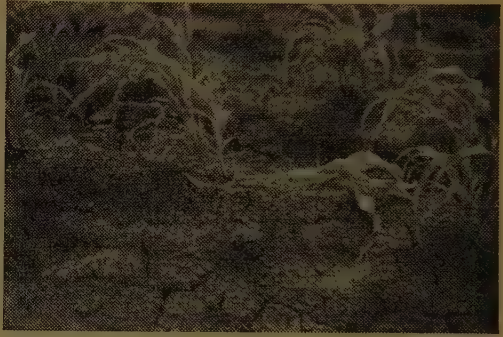


Fig. 2—Dura with damaged root system, falling over and producing precocious prop roots. Details as Fig. 1.

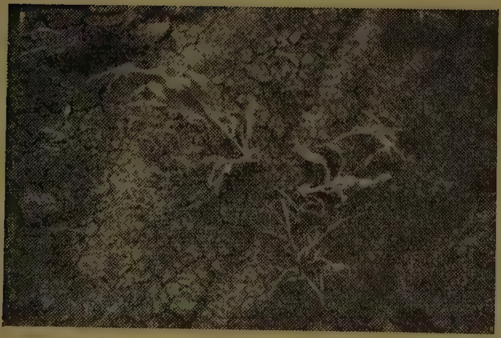


Fig. 3—Dura plant broken away from roots by wind; dying. Other plants in hole affected, but will survive. Details as Fig. 1.

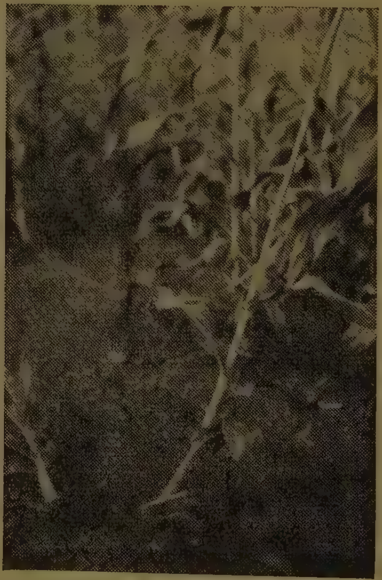


Fig. 4—Hole of recovered dura, 59 days after sowing, 45 days after spraying with 1 lb./acre sodium 2: 4-D. Note distorted base of plants (prop roots) and remains of original stems.

AMERICAN FOREST FIRE CONTROL METHODS

By W. E. M. Logan, Forest Department, Tanganyika; formerly Forest Department, Kenya

(*Received for publication on 28th September*, 1953)

The following note outlines some features of American forest fire control methods which may be of interest to Kenya. It is based on information obtained during a visit by the writer to the U.S.A. in 1950–51 and relates almost entirely to U.S. Forest Service methods.

METHODS

These can be divided into two stages, viz., pre-suppression and suppression.

Pre-suppression

This comprises such items as the prevention of fires by propaganda, public contacts and patrols, the look-out and reporting system, the preparation of fire plans, the construction of fire-breaks, roads and trails, the maintenance and location of suitable equipment at strategic points, the assessment of fire danger and the provision of stand-by crews during danger periods.

The Americans make much more use of propaganda as a means of preventing fires than we do. For this purpose they make liberal use of radio talks, the Press, public notices, posters, labels, stick-on slogans and badges, talks to schools, clubs and associations, etc., and individual public contacts by patrols and local fire wardens; in fact, any channel by which they can make the public more conscious of the dangers of forest fires and the evils which result from them.

They also have fairly stringent legal powers to control such items as smoking, camping, logging operations, etc., and to apply complete closures to forest areas if necessary. The latter is sparingly enforced but in many of the western states it is common practice to shut down all logging when the fire hazard reaches a certain degree. In many states it is also an offence to throw down lighted matches, cigarettes or other burning material anywhere, including along the highways, during the fire season.

The look-out and reporting system is based mainly on observation towers with telephone and radio communications. Formerly communications were mainly by telephone but the Forest Service are now going over more and more to radio as it eliminates the need for expensive line maintenance. When visibility between towers is bad, they also make considerable use of aircraft patrols as an aid to spotting and rapid reporting of fires.

Fire control planning is organized on Regional, Forest and District levels and covers such items as interchange of personnel and equipment between Regions and Forests in case of emergency, co-ordination with State fire control plans, correlation of Forest and District plans, the allocation of crews and resources to current hazards, training, and action for fire prevention and suppression. Much attention is paid to training of personnel at all levels, which is recognized as being one of the key factors in successful fire control. For this purpose various field courses are held periodically as well as training on the job, i.e., on actual "going" fires, whenever opportunity offers.

In general, wide fixed fire-breaks are going out of fashion. In the Depression days, when plenty of Civil Conservation Corps labour was available, an extensive network of wide fire-breaks was constructed in many forests but now that labour is so scarce and expensive the Forest Service find that they cannot keep them up. Experience has also shown that such breaks are useless, as a rule, to stop fires by themselves. The present doctrine is therefore only to construct fire lines on the job, i.e., as they are found to be necessary to control "going" fires and not to maintain large mileages of fixed breaks. For this purpose the Forest Service concentrate on putting in a planned and comprehensive network of tracks and tractor trails, mostly on ridges and crests, so that line-clearing crews and equipment such as bulldozers or ploughs can be moved to strategic points quickly.

Similarly, supplies of hand equipment are cached at suitable strategic points in the forests, while they are also kept packaged in crew units (e.g., 10-man crews, 20-man crews, etc.) at central stores ready for immediate despatch. As a rule, loggers working in National Forests are also obliged under their licence or lease to maintain in readiness certain specified items of fire equipment. These usually comprise one or more tanker trucks of 200–300 gallons capacity and portable power pumps plus the usual hand tools.

The assessment of fire danger is based chiefly on fuel dryness and wind velocity. The former is commonly measured by means of standard basswood sticks which are weighed at intervals to determine their moisture content and the latter by anemometer. These measurements are combined to give a burning index, which indicates the degree of fire hazard prevailing at the time. Measurements are made several times a day, if conditions warrant, at a network of stations sited so as to sample the usual range of fire weather and conditions. By adding successive burning indices, obtained as above, at a station together a cumulative burning index is obtained. This shows the fire danger trend and gives an indication as to when and where conditions are building up to an acute peak of danger. It thus enables precautionary measures to be put in hand, such as moving men and equipment to areas of expected trouble, putting crews on permanent stand-by, closure of forests, etc. In the latter case it also provides a statistical basis which is often helpful from a public relations angle in putting over the need for closure to the public.

Suppression

The objective is to gain complete control of the fire in the shortest possible time with the least effort. Three steps are normally required for this, viz., appraisal, fighting the fire, and mopping up and patrolling after the fire is under control.

Appraisal.—Appraisal, that is sizing up the fire and its future behaviour is the first step as on this the whole plan of attack is based. Correct and rapid appraisal of the existing conditions and the future behaviour of the fire is thus extremely important. The principal factors which must be taken into account include—

the location and size of the fire;

the types of forest or bush in which it is burning or in its immediate path;

topographic features which may influence its spread or facilitate control;

the weather;

crews, equipment and transport available.

Fire-fighting.—The next step is the actual attack on the fire. In general and particularly in the drier regions, fires are fought with fire. Water may be used to suppress small fires but for medium and large fires the main attack is usually by backfiring from fire lines and water is used as an auxiliary, i.e., to help hold the fire lines and for mopping-up purposes. The reason for this is the difficulty in most cases of getting on to the job sufficient water to put out a fire of any size.

Backfiring is normally organized in three phases, namely, line location, line clearing and line holding:—

(*a*) *Line Location.*—The main factors affecting this are the size and rate of spread of the fire, the principal danger points, i.e., points or sectors which must be attacked and held first, the topography, including type of country and cover, its accessibility and any natural features or barriers that can be used, the crews and equipment available and the time at which they can be brought into action. As a rule, the line will be located as near to the fire as the various factors outlined above permit.

(*b*) *Line Clearing.*—Mechanized methods are extensively used wherever conditions allow, as they not only save manpower but usually clear a better line quicker; as a rule they will clear line at rates up to 10–15 times as fast as with manual methods. In consequence manual methods are now only used as a rule on terrain where mechanized equipment cannot be operated. So much so that according to one senior officer there is a tendency for crews to rely entirely on mechanical equipment and to consider line clearing impracticable if it cannot be used. Mechanized equipment for fire line clearing includes ploughs drawn by jeeps or tractors, and bulldozers; the former are ordinarily restricted to grass and the lighter types of vegetation or to high forest where ground fires are the rule, while the latter are mostly used in the heavily timbered areas of the West. Hand tools commonly used comprise hoes, Pulaskis, rakes, shovels, axes and saws.

Lines are dug to mineral soil and of the minimum width and standard necessary to hold the backfire and prevent it from backing over the line; length and rapidity of construction are the prime objectives.

(*c*) *Line Holding.*—This comprises backfiring, i.e., burning out the unburnt vegetation between the fire line and the fire and holding the fire lines so that the backfire does not spread back over it. Backfiring is usually carried out simultaneously with the clearing of the fire line but at some distance behind its head. For setting the backfire fusees, torches and flame-throwers are commonly used, the latter being preferred for slow-burning vegetation. To hold the line, considerable use is made of water and portable pumps of various kinds.

Mop-up and Patrol

Lastly, when the fire is under control, comes the mop-up and patrol.

Mopping up comprises snag-felling, extinguishing burning stumps, logs and spot fires, and generally making the burnt area safe. Much importance is attached to it as there is often a tendency to relax after the spread of a fire has been stopped and the control line held and this, unless firmly checked, may allow the fire to break out and get away again. In snag-felling the customary practice is to take the most dangerous snags first; these usually comprise the most exposed ones such as on the crests of ridges, which may scatter sparks over long distances, and shaggy or partly rotten ones which may burn for a long time and scatter sparks heavily.

Crew Organization

Fire-fighting crews may be organized on a functional or sector basis. The first is very commonly employed for line clearing and holding while the latter is used more often for mopping up and patrol as it apportions territorial responsibility clearly and facilitates close supervision.

In the functional organization each member of a crew performs the same particular task throughout and moves forward at the same speed as the leader, remaining always in the same relative position in the crew. The organization may be illustrated diagrammatically thus:—

The continuous movement forward and the sense of visible accomplishment are said to stimulate the crews and this type of organization has been found to give the maximum output of held line. Spacing and control of the crew to prevent concertina-ing are important. For clearing and digging, men are commonly spaced about 10–15 ft. apart, so as not to interfere with each other's working; for back burning and line holding, the spacing depends on the type of bush or forest conditions, topography, weather and the number of men available. Untrained crews can be used quite successfully with this system provided adequate trained supervision is available.

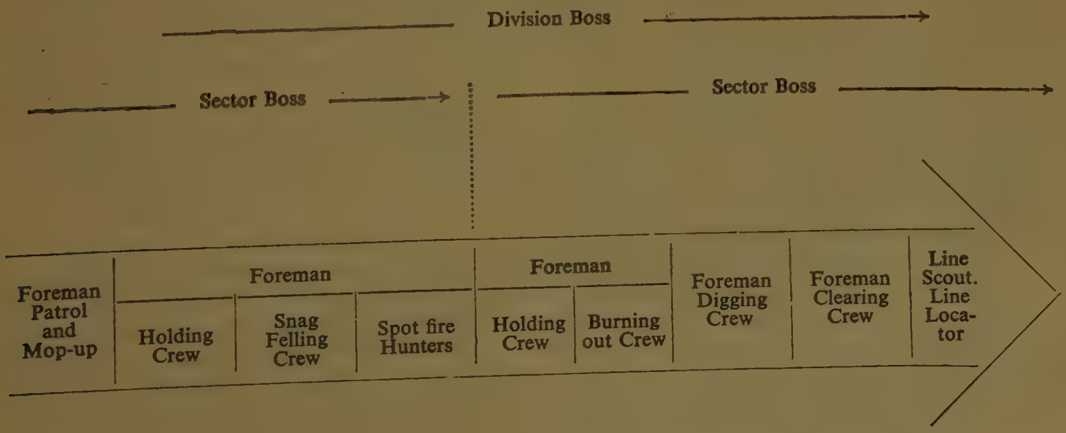
In the sector organization, each crew and man is given a definite section of the line for which they are responsible and from which they work in towards the centre of the fire.

EQUIPMENT

Communications

Radio is widely used, both for reporting and directing crews to fires and for controlling the actual suppression operations. It use undoubtedly saves a tremendous amount of time and money.

Four principal types of set are used, viz., portable or pack, tower or look-out, mobile (mounted in cars or pick-ups) and fixed station (H.Q.). Current practice is to use V.H.F., i.e., in the 30–40 megacycle band and up, with frequency modulation and two-channel communications. Automatic repeaters are commonly installed at suitable high points to increase the range and to enable communication to be maintained over broken ground; by



this means, contact can be obtained over intervening hill ranges or into deep valleys which would otherwise be out of touch.

The specifications for these sets have been drawn up by the U.S. Forest Service Radio Laboratory specially for the job of fire control and are based on a great deal of experience obtained over many years of actual fire fighting. The sets themselves are made by various commercial radio manufacturers to these Forest Service specifications and have an extremely high performance. Some notes on the various types follow:—

(i) Portable or Pack.—These are very light and handy, weighing from 10–20 lb., and easy to operate. Their range varies greatly according to local conditions, chiefly of cover and topography; on the average it is from two to three miles on the flat but may be 50 miles or more between intervisible high points.

(ii) Tower or Look-out.—These are fixed sets, usually incorporating an automatic repeater. They thus relay the portable or mobile sets to their H.Q. station or vice versa, as well as being able to talk to both and to other tower sets. Ranges vary greatly according to terrain and the elevation of the aerial; from high points ranges of several hundred miles are practicable. Under peculiarly favourable conditions they have been heard right across the American Continent.

(iii) Mobile.—These are mounted in cars, pick-ups, jeeps and trucks, and sometimes tractors. They can also be used as fixed station sets, if necessary. Their range is usually about 20–30 miles on the flat, but this can be greatly increased by operating from the top of a hill. When this type of set is installed in vehicles it is desirable as a rule to put in an extra heavy generator, to cope with the added drain on the battery.

(iv) Fixed Station.—These are installed at headquarters and may be of the tower or look-out type or special fixed station sets. The mobile sets can also be used for this purpose. In many cases, where these installations are at low elevations, the equipment is actually installed on high features, with remote control by land line, in order to get the maximum range.

Line Clearing

Mechanized equipment comprises ploughs and bulldozers. The ploughs are mostly used in the lighter types of cover or where only ground fires are encountered and the bulldozers in heavy bush and timber and in the more broken country.

The ploughs are of various kinds, according to the nature of the cover and the topography of the area in which they are used. In the Pacific North-west a tractor-mounted middle-buster type of plough is popular when the cover is not too heavy. In the South three types are commonly used, viz., a middle-buster in the mountainous areas where rocky soils are frequently encountered, a light middle-buster with rolling coulter in the grassy woodlands and a heavy disc plough in the dense reproduction and palmetto scrub of the woodlands of the coastal plains. The two first types make trenches 24–30 in. wide and can be drawn by quite light tractors, e.g., 18 h.p. or so, and in the case of the second by jeeps, but the third, which makes a trench 48 in. and up in width, requires a fairly heavy crawler tractor of the order of 35 h.p. or more. One advantage of the lighter units, apart from cheaper cost, is their mobility; they can ordinarily be carried on a $1\frac{1}{2}$-ton truck and can thus be quickly moved about. This factor of mobility is a very important one with mechanized equipment and the general trend in American fire-suppression equipment design is towards lighter equipment, which can be transported more easily and rapidly to the scene of the fire.

Standard heavy commercial bulldozers such as D7s and D8s are mostly used in the heavy timber and mountainous country of the West, but here again the Forest Service are experimenting with lighter units, such as D6s and smaller, in order to improve mobility.

Portable Pumps

These are of three basic types, viz., back-pack units, portable power units and pumps used in combination with pick-ups or trucks.

(i) Back-pack Pumps.—These are self-contained units similar to those used in Kenya and are widely employed to suppress small spot fires, to help hold fire lines in backfiring and for mop-up work.

(ii) Portable Power Units.—These are complete pump and motor units which can be carried by hand or back-packed for considerable distances over various kinds of ground and cover. Weights vary from about 40–100 lb. Two types are employed, namely, the rotary and the centrifugal. The former comprise two intermeshing gears or cams which revolve at high speed in a close-fitting housing. They give very high pressures but for satisfactory performance have to be built to fine clearances. They are thus not suited for use with water which contains abrasive material, such as mud or sand, as this soon wears the pump and causes performance to fall off. The centrifugal pump, on the other hand, does not give such high pressures but, as the clearances are greater, is far less affected by muddy or sandy water. The rotary pump is the more precision and higher performance equipment of the two and is therefore generally more expensive and difficult to maintain. The working life of these pumpers between major overhauls varies from 4–100 hours continuous pumping, depending on the treatment of the pumper and the amount of abrasive in the water. Power units may be 2- or 4-stroke motors; the Forest Service prefer the 4-stroke, as they have found them more reliable.

High pump-operating pressures are customarily employed, particularly in mountainous country to cope with the high lifts entailed and to conserve water. With the rotary pumps water pressures of 200–300 lb./sq. in. at the pump are common practice and discharge rates vary from 15–20 g.p.m. In this connexion it may be remarked that research has shown that the least quantity of water needed to deal effectively with most Southern California fires is 8 g.p.m.

(iii) Pick-up- or Truck-mounted Pumps.—In their early stages of development in this field the Forest Service followed much the same lines as urban fire-fighting and went in for large tankers and heavy pumps giving a high discharge rate, e.g., of the order of 150 g.p.m. These units had very low speed and mobility and later ideas have been towards the development of light equipment using much less water and possessing much greater mobility. Lighter units of this kind are also generally a good deal cheaper and hence a better coverage can be obtained for the same money.

As a result, "slip-on" tankers have been developed. These are relatively light tank and pump units which can be quickly placed in or taken out of standard trucks and pick-ups. Two principal types have been designed:—

(*a*) A small-size unit, water capacity 160–200 gallons, for use with Willys one-ton and similar pick-ups; and

(*b*) a larger unit, water capacity 250–300 gallons, for use with Dodge power-wagons and similar capacity trucks.

Both these units incorporate their own power-driven pump and hose and are thus entirely self-contained. Similar units are employed as standard equipment by many State Forest Services and private woodland owners and they appear to be very handy and popular. They are more flexible than the fixed type tanker in that they can be moved from one truck to another, in the event of one becoming unserviceable, while they also allow the trucks to be used for other purposes when not required for fire-fighting. By incorporating their own power unit they are also independent of the truck motor.

In fitting up small tanker units of these kinds there is generally a tendency to overload the carrying truck, so that its performance and possibly its safety are adversely affected. This needs constant watching. The U.S.F.S. slip-on tankers have been specially designed to keep within the permissible weight limits of the various trucks concerned.

(iv) Hose.—Standard Forest Service hose sizes run from ¾–1½ in. For the bigger pumpers (e.g., capacity up to 100 g.p.m.) and long lays, say more than 1,000 ft., 1½-in. hose is normally used and for the smaller pumpers and shorter lays (1,000 ft. or less) 1-in. or even ¾-in. for very short distances. Hose for use with the pumps described above should be capable of withstanding pressures of 200–300 lb./sq. in. For this purpose, cotton-jacketed, rubber-lined (c.j.r.l.) hose is preferred, especially where water is scarce. If water is plentiful, linen hose may be used but it has the disadvantage of allowing considerable loss of water, due to seepage, and it may also mildew badly unless treated; on the other hand, it is more easily portable and owing to its seepage resists burning better than the c.j.r.l. hose.

The usual allocation of hose is about 1,000–1,500 ft. per pumper for large units and 500–1,000 ft. for the small units. It is normally packed in 50-ft. lengths in the case of c.j.r.l. and 100-ft. lengths in the case of linen hose.

(v) Nozzles.—Very small nozzle apertures are generally used, in order to conserve water. The usual size ranges from ⅛–¼ in. with the optimum about ⅛–$\frac{3}{16}$ in. for straight stream nozzles. Several kinds of nozzle, both straight stream and spray and of various degrees of elaborateness are used but the ordinary adjustable garden hose nozzle also does a remarkably good job at a very low cost.

Motor Vehicles

The general trend in regard to vehicles for fire-control work is to use lighter and more mobile units; the objective is a light four-wheel-drive vehicle with which crews and a reasonable quantity of equipment or water can be got to the fire quickly, followed, if necessary, by heavier units later. The emphasis is on mobility.

First-line transport is usually a ½–1-ton pick-up, preferably with four-wheel drive. Jeeps are not popular for this purpose because their payload is too small and they are also considered dangerous as they turn over easily due to their narrow track and relatively high centre of gravity. For similar reasons, jeep trailer-tankers are not liked; the load behind is liable to cause jack-knifing when going downhill and they are apt to overturn on difficult ground. On the whole, pick-ups such as the Willys 1-ton, which has four-wheel drive, and can take a bigger payload than the jeep are preferred; they are also said to be safer and to give an easier ride, and hence to be less tiring for the crew.

For second-line transport the Dodge power-wagon, which has four-wheel drive, is much liked. Standard commercial 1½–2-ton trucks are also widely used, again preferably fitted with four-wheel drive if opportunities exist for cross-country travel.

A few "Weasels", corresponding to our Bren-carriers, have been adapted for transporting stores and equipment across country but are not very widely used. Their principal disadvantages are high costs of operation and maintenance.

Aircraft

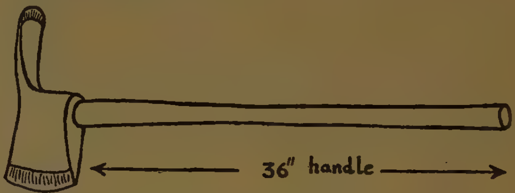
Planes and helicopters are used for reconnaissance and transport when conditions warrant. They are particularly useful for spotting when visibility is bad and for the co-ordination and direction of suppression work on large fires in inaccessible or little-known country. They are also used as a rapid means of transportation and supply for fire-fighting in inaccessible areas, such as to drop "smoke jumpers" and equipment and supplies to ground crews, or to bring out injured personnel. They are used sparingly, however, as they are too expensive for general use.

Hand Tools

The principal standard hand tools include axes, cross-cut saws, brush hooks, Pulaskis, rakes, hoes, shovels and swatters.

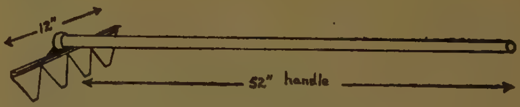
Brush hooks are like bill hooks mounted on a long handle, about 36 in. long. They may be double- or single-edged and are much better than an axe for slashing and cutting small material under 4 in. diameter.

Pulaskis are a combination of an axe and grub hoe, thus:—



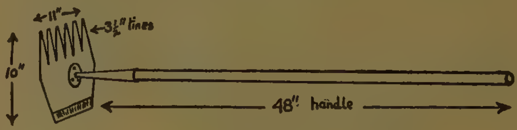
The hoe is at right-angles to the axe blade. This combination of digging and cutting tools is very useful in line clearing and mop-up work.

One of the most popular rakes is the mower blade rake. This is made of four sections of mowing machine knife fastened to an angle-iron and fixed to a handle to form a rake thus:—

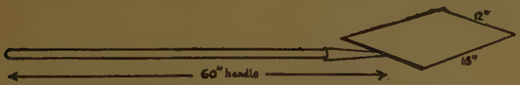


This type of rake is very suitable for clearing lines in light bush and in duff containing small roots as it can be used for both raking and cutting.

Another tool which is widely used is the McLeod which consists of a combined rake and hoe, as sketched below. The hoe is useful for cutting through heavy duff and matted bush cover and for trenching, grubbing and slashing low limbs while the rake enables litter, bush and other cut material to be easily hauled out. It is reported to be a very effective tool.



A very useful swatter which is commonly employed in the South on fires in grass and light cover consists of a piece of old belting, about 12 in. wide and 15 in. long, fastened to a steel bar and mounted on a long handle. This type of swatter was observed to be particularly effective for putting out grass fires. It should be used quite gently rather than "swatted" vigorously as the latter tends to spread the fire.



The other hand tools are well known and need no description here.

For snag felling and clearing fire lines of fallen trees and logs power chain saws are very widely used, especially in the West where the timber is big. Provided the operators are well trained they are very effective for this and undoubtedly save a great deal of time and fatigue.

Organization

The fire-control organization of the U.S. Forest Service is broadly as follows:—

Chief, Division of Fire Control	Responsible to the Chief of the U.S. Forest Service for all Forest Service fire control. He is assisted by an Asst. Chief and an Equipment Engineer and has his headquarters at Washington, D.C.
Region Regional Chief of Fire Control	Responsible to the Regional Forester for all Forest Service fire control within his region. He normally has two to four assistants including a Regional Despatcher.
National Forests Fire Control Officer	Responsible to the Supervisor of the National Forest concerned for all fire control in his charge. Assisted by a Despatcher who is responsible for the assembly and despatch of fire-fighting forces and equipment to fires.
Ranger District Fire Control Assistant	Responsible to the District Ranger for fire control in the district.
Guards, look outs, patrols and suppression crews	

Fire control is thus organized as a specialist branch of the Service and the various Fire Control Officers act as specialist assistants and staff officers for that purpose to the Regional Foresters, National Forest Supervisors and District Rangers.

In addition the Forest Service maintains its own Equipment and Radio Laboratories for developing and evaluating all kinds of equipment used for fire-control purposes.

The organization on actual "going" fires naturally varies according to the circumstances of each case. As a general principle, the best-qualified person is placed in charge. The diagram on p. 246, reproduced from a U.S. Forest Service publication,* shows an example of fire-line organization for the suppression of a large fire; the various posts and crews are, of course, modified to suit the particular conditions of each fire and may not all be necessary in every case.

Finance

The following figures of the amounts normally spent by the Federal Government through the medium of the Forest Service on fire control may be of interest. They are given for various regions, as conditions differ markedly in each.

Region 1. Eastern Slopes of the Rockies (Montana and Idaho)

Area protected: 30,000,000 acres approx.

Average annual expenditure—

(i) pre-suppression—
£535,000 = Sh. -/36 per acre.†

(ii) suppression—
£355,000 = Sh. -/25 per acre.

This region is very mountainous and large tracts are inaccessible, entailing 30–40 miles of foot travel to get in. In consequence "smoke jumpers" (parachutists) are used a good deal. The fire season is normally about three months (July–September) of which the last half can be very severe. The fires commonly crown and can be very fierce.

Expenditure on pre-suppression is about 60 per cent of the amount reckoned desirable.

Region 5. California

Area protected: 25,000,000 acres approx.

Average annual expenditure—

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* Fire Control Handbook, Region 6. Part III—Suppression, Chapter 1—Firefighting. 1945. Region 6, U.S. Forest Service.

† Dollar figures converted to £E. African at $2.80 = £1.

(i) presuppression—
£1,070,000 = Sh. -/85 per acre;

(ii) suppression—
£890,000 = Sh. -/70 per acre.

In a really bad year the suppression expenditure may run as high as £1,600,000. Pre-suppression costs are fairly constant.

In addition to the foregoing the State of California spends on the average about £3,570,000 per annum for the protection of some 30,000,000 acres, i.e., about Sh. 2/20 per acre per annum.

An average of about 1,300–1,500 fires occur per annum. Fires are generally fairly fierce, especially in the southern part of the State where there is a lot of highly inflammable chaparral scrub and a long (six months) dry season. In the North the fire season is rather less (about four months) and there is more heavy timber so that costs are lower than in the South.

The pre-suppression expenditure represents about 40 per cent of that which is considered desirable.

Expenditure on equipment, including operation and repair, averages about 10 per cent of the pre-suppression costs, i.e., about £107,000 and on suppression work, about 20 per cent of the total suppression costs. The higher figure for suppression is largely due to the fact that they hire a great deal, such as bulldozers and tankers, from private owners. Of the total equipment held by the Region, about 48 per cent by value, equivalent to some £800,000, is in respect of fire-control equipment. Numerically the latter includes, *inter alia*, about 450 pick-ups and jeeps, nearly 100 trucks and about 550 power pumper units of various types.

Region 6. Oregon and Washington (the Douglas Fir Region)

Area protected: 27,000,000 acres approx.

Average annual expenditure—
(i) presuppression—
£445,000 = Sh. -/33 per acre;

(ii) suppression—
£355,000 = Sh. -/26 per acre.

This region is mountainous with dense stands of big timber. There is also much slash on the ground from past logging operations, which constitutes a high fire hazard. The fire season is about 3½ months and can be very severe in August and/or September.

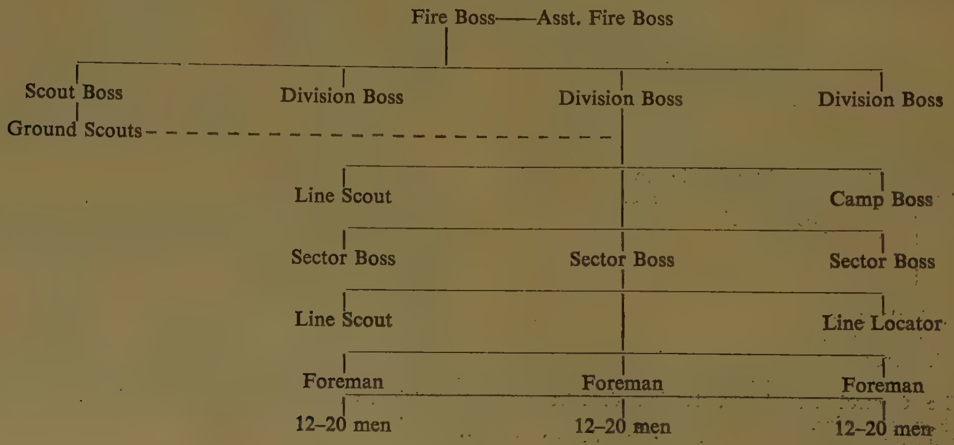
Expenditure on pre-suppression is about 60 per cent of the desirable amount.

Region 8. The Southern Pine Region (i.e., the South-east from Virginia to Texas)

Area protected: 15,000,000 acres approx.

Average annual expenditure—
£355,000 = Sh. -/47 per acre.

Except for the Appalachian Mountains, which are predominantly hardwood, the area is mostly easy terrain, varying from flat to rolling. Fires are mostly ground and rarely crown. They are very numerous, about 2,400–3,000 per year, of which 90 per cent are maliciously set. Fire control is very highly



mechanized and mobile, mostly by means of plough suppression units. The average duration of a fire in this region is about 20–25 minutes which is an indication of the speed with which they are tackled.

The foregoing figures show that in the major fire danger regions the U.S. Forest Service spends on the average from Sh. 0/33–0/85 per acre per annum on pre-suppression and another Sh. 0/25–0/70 on actual suppression; the highest figure for both is California (Region 5) where they spend on the average Sh. 1/55 per acre per annum on fire control, and in a really bad year may spend over Sh. 2 per acre. It will be noticed that in each case more is spent on pre-suppression, i.e., prevention, than on actual suppression.

It may be of interest to translate these costs to Kenya conditions, in so far as that can be done. California may be taken as the most comparable region to Kenya in regard to fire hazard and burning conditions. On the basis of the figures for California, Kenya would spend at American rates about £136,000 on pre-suppression and £112,000 on suppression, i.e., about £248,000 in all. Assuming that the greater part of this, say, 85 per cent, is in respect of labour, the figures become £37,000 on equipment (purchase, operation and maintenance) and about £211,000 on labour, or at equivalent Kenya rates in 1952, approximately £3,000 for labour, making a total of about £40,000 in all. In fact the Kenya Forest Department spends about £14,000 per annum on fire control. Kenya fire-fighting is nothing like so mechanized as American methods, however, and most of the expenditure is in respect of labour, i.e., Kenya spends much more on labour than the Americans would and much less on mechanized equipment. This derives from the relatively abundant supplies of cheap unskilled labour on which Kenya can call at present, and is what would be expected in the present (pre-Emergency) stage of the Colony's development. Whether this pattern will be maintainable in the future is very doubtful. In the writer's opinion, as labour costs continue to rise without any noticeable increase in productivity or skill, Kenya will be obliged to rely much less on purely manual methods and make a great deal more use of mechanization. Again, it can hardly be upheld that Kenya's present expenditure on fire-fighting confers adequate security, i.e., that it can be regarded as the desirable expenditure. There are still too many areas with insufficient roads and paths for quick access in the event of fire, too many stations with inadequate communications in the shape of radio or telephone with which to report fires and despatch fire-fighting crews quickly, and too little actual suppression equipment. In sum, therefore, greater expenditure is likely to be required for fire control in Kenya in the future, with an increasing proportion spent on equipment rather than on labour.

CONCLUSION

In essence, the lessons to be learnt from American methods are that prevention is better than cure and that the keys to successful fire-fighting are good communications, good equipment and well-trained crews.

In Kenya, more might well be done on the prevention side to build up greater fire-consciousness by means of talks to schools, meetings and on the radio, by articles in the Press, and by leaflets and posters, etc. Most of the fires in Kenya are caused by man either through carelessness or maliciousness and it should be possible to prevent most of them by better education of the public.

On the fire-fighting side a good deal of progress has been made towards better communications by improving and extending the forest road network, but there is still much to be done both in regard to roads and also towards providing better communications between stations in areas of high fire danger. As one American Regional Fire Chief pithily observed, "One man can put out any fire if he can get there soon enough". The problem is to get him there soon enough. Clearly, forest roads should be extended with all possible speed and the network of tracks and inspection paths should also be strengthened with the aim of dividing the inflammable forests into small blocks into any part of which quick access can be gained and of providing lines from which to fight a fire. The reporting of fires and the despatch of fire-fighting crews could also be considerably speeded up. In the States the usual interval between the first report of a fire and someone being despatched to it is a matter of 3–15 minutes; in Kenya it may be several hours The use of radio would reduce this time-lag a lot and also save much transport which is at present employed in investigating reports of fires or sighting of smoke. It would also facilitate the co-ordination and speed up the control of separate fire-fighting forces on "going" fires. The application of V.H.F. radio to fire-fighting in Kenya should therefore be investigated.

In view of the scarcity of water which prevails over most of the more inflammable forest areas it is suggested that more consideration should be given to fighting fire by fire, i.e., to line clearing and back burning and that in most cases water should be regarded as a useful auxiliary rather than as a main means of attack. Water supplies can and should be improved where possible by the construction of dams and storage tanks at suitable locations, keyed in with the road system but in most cases the main attack will of necessity have to be based on other means than water. Counter-firing is admittedly difficult and needs skilled crews and the tendency in Kenya has therefore been to regard it as a last resort. If properly done it is effective and economical, however, and it is suggested that more use could be made of it with advantage in Kenya, particularly in districts where water is scarce and labour is becoming hard to get.

The present practice of maintaining wide fire-breaks also needs reconsidering. They are very expensive to keep up and will rarely stop a strong fire by themselves. It is suggested that better, and probably cheaper, protection will be afforded at least in the high forest areas by the clearing of narrower and more numerous lines which will provide quick access and a base from which to fight a fire, rather than by seeking to maintain a few very wide breaks. This will become even more necessary as the application of intensive forest management extends. The effectiveness of these lines could also be materially increased by planting their edges, where site conditions permit, with non-inflammable species.

On the equipment side the greater use of ploughs and other rapid and labour-saving line-clearing equipment merits consideration. As the mileage of lines extends some degree of mechanical clearing will have to be adopted, otherwise it will be impossible to keep the lines open, quite apart from the need to speed up construction of *ad hoc* lines on "going" fires. The extension of the forest road system will enable more use to be made of mobile tankers and pump units and these should be improved and increased in numbers in order to enable the maximum fire-fighting power to be deployed. The present power pumps in particular are too heavy and use far too much water and a much lighter and more economical type is needed. For this the slip-on unit suitable for 3-ton trucks seems to offer the best possibilities.

The scientific assessment of fire danger should be studied. At present, assessment depends on the judgment and experience of individual foresters. No actual data are available but it is very probable that this leads to the wasteful standing-by of labour in some cases where the danger may be overrated or to the ignoring of a high state of hazard and hence running unnecessary risks in others. It is therefore desirable that more scientific methods of fire-hazard assessment should be introduced, the more so as the recent expansion in the department has reduced the proportion of officers with long experience of particular local conditions and hence has tended to make personal assessment a good deal more fortuitous than perhaps it was before. Assessment based on measurable factors such as the dryness of standard sticks and wind velocities will give a far sounder basis than is available at present on which to put into effect pre-suppression measures such as the closure of forest areas, the restriction of logging operations or the standing-by of fire-fighting crews at strategic points, and hence will lead to more efficient fire control, as a whole.

Lastly, more attention should be devoted to training, if not of all labour, at least of key personnel and crews. Periodic fire drills and instruction in the proper use of the various kinds of equipment are two immediate and essential ways in which this can be done. Conferences and short courses in planning, organization and methods should also be instituted, as opportunity exists, for the more senior officers and foresters who would normally provide the directing staff on "going" fires. Unless well-trained staff and crews are available better equipment and better communications will be of little avail.

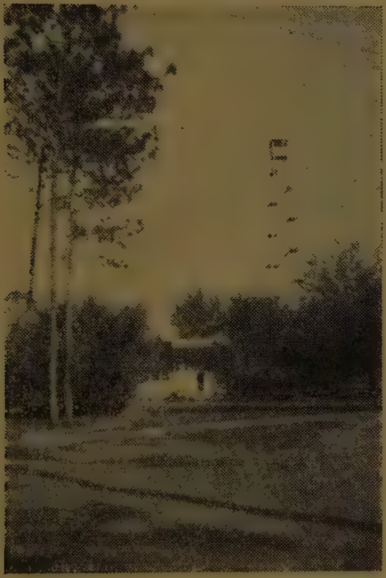


Fig. 1—100-ft. steel look-out tower. The tower is equipped with radio and telephone communications. U.S. Forest Service, Osceola National Forest, Fla.

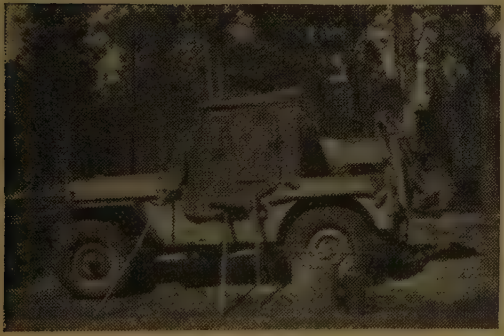


Fig. 2—Jeep fire-control unit with light plough mounted at rear. The plough is in the raised position for transport and is raised and lowered by cable from a winch between the driver's and passengers' seats, i.e. the driver can operate it from his seat. Other equipment includes two beaters, one mower blade rake, axe, back-pack pump, drip torch for back-firing and radio (mounted on far side of Jeep and not visible in picture). Gaylord Container Corporn., Bogalusa, La.

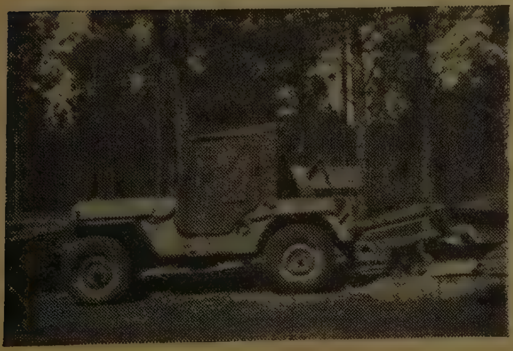


Fig. 3—Jeep, as in Fig. 2, with fire plough lowered for ploughing.

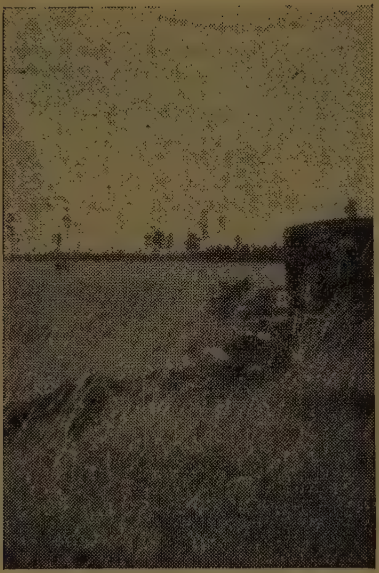


Fig. 4—Jeep fire-control unit in action, ploughing a line to control a grass fire. This type of unit is only suitable for open country; it cannot operate in heavy bush.

Fig. 5—A fire-suppression unit consisting of a 35-h.p. crawler tractor and a heavy disc plough. The unit is transported on a specially strengthened 2½-ton truck.

DAGAA FISHERIES IN LAKE TANGANYIKA

By G. J. Lockley, Inland Fisheries Officer, Department of Agriculture, Tanganyika Territory

(*Received for publication on* 30*th January,* 1954)

The dagaa industry of Lake Tanganyika is the Territory's most valuable inland fishery. The small sardine-like dagaa are marketed in a sun-dried form and this product is in great demand by employers of fed labour, particularly in the sisal industry. Over the past few years, sales of the value of exports of dried dagaa from the Lake Tanganyika area has been of the order of £150,000 per annum and approximately one-third of this amount is usually obtained in hard currency from sales to the neighbouring Belgian Territories. On the production side the industry is entirely in the hands of Africans and at least 6,000, using upwards of 2,000 canoes, are believed to be engaged in the fishery.

The fishery is conducted at night and only during those nights, or hours of the night, when there is no moonlight. The fishing method depends on attracting and concentrating the fish beneath a light on each canoe; when sufficient fish are concentrated beneath the light they are scooped up in a large dip net. For many years the method of illumination used for attracting the fish has been a wood fire carried on a small iron grate fixed forward of the canoe. A considerable quantity of fuel must be carried in each canoe for a full night's fishing. Of the crew of three, one man is fully employed as "stoker" in tending the fire. Smoke and sparks from the fires cause much discomfort to the fishermen and damage to their nets and clothes. Obvious difficulties with the fires are encountered during the rains.

However, the greatest disadvantage of all in the use of these fires, lies in the fact that the wood fuel or *mwenge* used, is almost exclusively the heart-wood of one species of tree—*mkurungu* (*Pterocarpus chrysothrix*), which has the property of burning with a bright flame and little smoke. This species has been cut out to a considerable depth from the lake shore, a matter which has given much concern to the Forest Department. Whereas in the past the fishermen used to cut their own fuel, the necessity nowadays to go so far afield for it has led to the establishment of fuel suppliers who transport the *mwenge* to the lake shore for sale. Many fishermen are dependent on this source, and the cost to the fishermen of sufficient *mwenge* for an average night's fishing for one canoe is of the order of Sh. 30 to Sh. 50 per canoe load. In times of scarcity of fish, many fishermen are operating at a loss with this excessive overhead.

It became obvious that one of the main tasks of the Inland Fisheries Officer was to discover a cheap and efficient substitute for *mwenge* and to persuade the fishermen to adopt it. Over the past two years experiments have been conducted with a variety of flares and lamps. Some were unsuccessful in attracting fish, others presented difficulties of operation or maintenance or were viewed with a remarkable lack of enthusiasm by the fishermen. In the latter half of this year the answer was found in an ordinary paraffin pressure lamp of the hurricane or storm lantern type, of 300 to 350 candle power, fitted with a reflector to direct the light on to the water. Such lamps, complete with reflector, at present retail through normal commercial channels in Kigoma for Sh. 110 to Sh. 150 each, depending on the make. Operating costs are from cents 50 to Sh. 1 per night, plus occasional expenditure for spirit, spare mantles, etc.

Experimental successes with this lamp were followed up by an intensive campaign of demonstrations and propaganda amongst the fishermen. Response was very slow at first, but outstanding successes by one or two enterprising fishermen who were persuaded to try the lamp under normal fishing conditions and who reported not only catches as good as, but in several instances better than those made under *mwenge* fires led to a stampede to acquire lamps. This, to a certain extent found Kigoma retailers and Dar es Salaam importers unprepared. Although they had been kept informed of the progress of the work it had not been anticipated that the demand would be so rapid or so large. Every lamp of suitable type available in the Territory has been sent to Kigoma and has been immediately sold. Several dealers, now awaiting supplies, have large paid-up orders from African fishermen. At the time of writing some two to three hundred lamps are already in use on the lake and, had supplies been immediately available, very many more could have been sold. This office is daily besieged by fishermen wanting to know where they can buy such a lamp and by Asian traders seeking assistance in obtaining wholesale supplies. Further considerable supplies are expected from the U.K. shortly, and it is pleasing to report that the experimental prototype was of British manufacture and is the type preferred above all others by the African fishermen.

There is little doubt that, once adequate supplies are forthcoming next year, the major part of the industry will be re-equipped with lamps. Some of the canoes are owned or operated by the fuel suppliers and in some instances the fishermen are in debt to them. It appears likely that this section of the industry will continue to use *mwenge*, but the Conservator of Forests, N.W. Region, who has closely followed the progress of this project, informs me that, once the use of lamps is well established, he intends to issue no further licences for the cutting of *Pterocarpus* for fuel purposes.

From all the foregoing, the considerable advantages accruing from the success of this simple project will be apparent. Apart from the forestry considerations and the many direct benefits to the fishermen, the lowering of production costs should lead to reduction in the price of dagaa to the consumer.

BUSH-CLEARING AND GRAZING TRIAL AT KISOKON, KENYA

By A. Bogdan, Pasture Research Officer, Department of Agriculture, Kenya

(*Received for publication on* 22*nd January*, 1954)

The trial reported here was established by the Department of Agriculture in connexion with a project to move livestock temporarily from badly overgrazed and eroded areas of the Baringo district to the Esageri and Kisokon land units bordering this district at the south. The area intended for temporary settlement was covered with thick *Acacia* woodland. It was proposed to clear the bush in a small portion of the area and to observe the effect of management on regeneration of the bush and on the grass cover, and to assess the grazing capacity of the cleared land.

In 1947–48, 100 acres of bush were cleared and 20 5-acre plots fenced. The treatments, which included cattle and goat grazing, burning, mowing, and complete protection, commenced in November, 1948, and were discontinued in October, 1951, in connexion with changes in the original project. In spite of short duration the trial produced some useful information. The plots were situated near the Molo River bridge on the Nakuru–Eldama Ravine road, about 20 miles north-west of Nakuru at an altitude of 5,500 ft. The soil of the plots is red sandy loam.

RAINFALL

The nearest station where rainfall has been recorded is Rongai which lies some ten miles south-west of the Kisokon plots. As Rongai is situated some 700 ft. higher (6,200 ft.) and the rainfall in this area decreases rapidly towards the north-east, the rainfall at Kisokon should be lower and can be roughly estimated at 25–30 in. per annum as compared with 35 in. at Rongai.

The distribution of rainfall at Kisokon more or less follows the Rongai pattern. Monthly rainfall figures for the three years of the trial, as recorded at Rongai, are shown in the table opposite.

The figures show that the years 1949 and 1950 were drier than the average while 1951 was an exceptionally wet year. The average for these three years is 2 in. higher than the mean rainfall for 21 years. However, October, November and December, when the treatments were already discontinued, contributed very much to the 1951 rainfall and, excluding this part of the year, the rainfall for the three years of the trial was slightly below average.

Exceptionally high rainfall in October–November–December, 1951, made it possible to study the recovered herbage in January, 1952, without awaiting the April–September rains.

Rainfall at Rongai in Inches

Months	mean for 21 year	1948	1949	1950	1951
January	0·69		0·00	0·39	0·27
February	1·13		0·32	0·02	0·36
March	2·87		0·24	2·15	4·37
April	5·73		8·99	4·14	14·14
May	3·74		2·93	2·03	3·13
June	3·06		3·85	2·95	2·01
July	4·85		4·55	7·48	2·93
August	4·20		4·10	3·71	5·05
September	2·51		3·30	2·94	2·54
October	1·84	2·44	0·97	0·98	3·62
November	1·83	1·64	0·90	0·96	3·17
December	1·93	0·96	0·81	0·25	8·33
Total	34·38		30·96	28·00	49·92

TYPE OF VEGETATION

The natural vegetation of the plots before clearing consisted of *Acacia* woodland. The plots had been cleared before the observations were commenced and the original vegetation was not recorded. It can be assumed, however, that it was similar to that of the adjacent area of uncleared land. This was covered by thorn woodland dominated by the following trees and shrubs:—

Trees 30–35 ft. in height: *Acacia senegal, Acacia hebecladoides, Acacia seyal.*

Trees 12–20 ft. in height: *Acacia subalata, Albizzia amara, Tarchonanthus camphoratus.*

Shrubs: *Acacia pennata, Dichrostachys glomerata, Phyllanthus guineensis.*

The woody vegetation was uneven; dense growth of trees and shrubs alternating with frequent glades or less dense bush.

Herbaceous cover was also not uniform. In shady places it consisted mainly of herbs typical of forests and forest edges, such as *Pavonia burchellii, Hypoestes verticillaris, Coleus kivuensis,* etc., and some annual grasses. In more open places herbaceous cover consisted mainly of the grasses typical of open grassland or thin bush, such as *Cynodon dactylon* and *C. plectostachyum* (Star grass), *Sporobolus phyllothrichus, Sporobolus pyramidalis, Themeda triandra* (Red Oat grass), and *Cymbopogon pospischilii.* A number of annual grasses (*Chloris virgata, Aristida keniensis, Setaria pallidifusca, Eragrostis cilianensis,* etc.) were also present.

In the area intended for trial, trees and larger shrubs were cleared by tractor, the remaining smaller shrubs by hand. Some trees were left for shade. These included *Acacia seyal, A. senegal, A. hebecladoides,* and *A. subalata.* In October, 1948, at the beginning of the trial, in the portion of the experimental area cleared first (in 1947), tufted perennial grasses, particularly *Cymbopogon pospischilii* were dominating in the herbage; large colonies of Star grass and numerous annuals were also observed. In the portion cleared later (in 1948) tufted perennial grasses were less numerous and the herbage consisted mainly of Star grass, annual grasses and herbs.

TREATMENTS

The treatments included cattle and goat grazing at different rates and seasons, mowing, burning and complete protection. Continuous grazing of cattle at two rates was compared with grazing during the wet and the dry seasons. These treatments produced a marked effect on the grass during three years of the trial. Two other types of cattle grazing were designed for a longer period of trial and they did not produce any convincing results. The main types of goat grazing included continuous grazing, dry and wet season grazing and heavy stocking of short duration. The other treatments were introduced having in mind a longer trial.

The treatments and the number of grazing days are shown in the table below. It should be noted that at times difficulties arose in getting large numbers of goats for plots 15 and 16 (heavy stocking for short duration) and the proposed treatments of these plots were not always put into practice. All cattle and goats used in the trial were of local native stock. They were small, weighing at most half as much as the normal European cattle. The carrying capacity in terms of acres per beast would have to be at least doubled for the normal-size cattle.

Plot No.	TREATMENT	Grazing Days per Year	Acres per Head per Year
	CATTLE GRAZING		
1	Continuous grazing—5 head (with an interval from 29–11–50 to 15–5–51 due to lack of grazing)	278	1·3
2	Continuous grazing—2 head (with an interval from 10–1–51 to 15–5–51)	191	1·9
3	Dry season grazing—8 head	207	1·8
3	Wet season grazing—8 head	218	1·7
6	Alternate wet and dry season grazing—8 head	152	2·4
7	Dry season grazing plus wet season grazing once in 3 years—8 head	262	1·4
	GOAT GRAZING		
20	Continuous grazing—25 head	1,448	0·25
12	Continuous grazing—10 head	824	0·44
9	Dry season grazing—25–100 head	2,075	0·18
11	Wet season grazing—25–100 head	2,485	0·15
13	Alternate dry and wet season grazing—50 head	1,177	0·31
14	Dry season grazing plus wet season grazing once in three years—50 head	1,463	0·25
15	Heavy stocking for short duration at end of rains	2,000	0·18
16	Heavy stocking for short duration twice a year (discontinued due to lack of animals)	873	0·42
	MOWING		
5	Complete protection from grazing. Mown twice yearly—in June and October.		
10	As plot 5. Grass removed.		
	BURNING		
18 and 19	Complete protection from grazing. Burnt at the end of dry season.		
	COMPLETE PROTECTION		
8 and 17	Complete protection.		

REGENERATION OF BUSH

At the beginning of the trial, soon after the bush had been cleared, seedlings of many of the trees and shrubs observed in the original woodland began to appear. The most numerous young plants belonged to *Acacia* (particularly *Acacia seyal* and *A. senegal*) and to Ol'Leleshwa (*Tarchonanthus camphoratus*). After the three years of the trial the *Acacia* seedlings reached 5–7 ft. in height in plots grazed by cattle.

Regeneration of bush was estimated by scoring and the following 5-point scale was used:—

1. Very thinly scattered plants.
2. Thinly scattered plants.
3. Fairly numerous plants.
4. Numerous plants.
5. Abundant plants.

Final estimates, recorded in January, 1952, were as follows:—

Plot No.	TREATMENT	Thorn Bush	Ol' Leleshwa
1	Cattle grazing	5	2
2	Cattle grazing	4	2
3	Cattle grazing	5	2
4	Cattle grazing	5	3
5	Mowing	2*	0†
6	Cattle grazing	4	2
7	Cattle grazing	4	2
8	Complete protection ..	3	2
9	Goat grazing	2	4
10	Mowing	2*	0†
11	Goat grazing	1	3
12	Goat grazing	1	1
13	Goat grazing	1	2
14	Goat grazing	1	2
15	Goat grazing	1	3
16	Goat grazing	1	3
17	Complete protection ..	3	3
18	Burning	1	2
19	Burning	1	3
20	Goat grazing	1	3

*Low and weak.

†None observed.

Regeneration of thorn bush was clearly correlated with the treatments. Goats suppressed or even killed the young growth of *Acacia* by eating the leaves repeatedly and *Acacia* thorn was very scarce and comparatively low, mostly 3–4 ft. in height, in the plots grazed by goats. Burning produced almost the same effect, considerably suppressing regeneration of thorn bush.

In the plots mown twice a year thorn bush tended to reappear but was kept down. After being cut repeatedly the young *Acacia* plants became very weak and most of them died in about two years' time. Although the number of plants of young *Acacia* was somewhat larger than in the plots grazed by goats they were low and very weak. After first cuttings the bush often acquired a spreading habit; however, next cuttings usually weakened the bush so much that the horizontal growth was also suppressed.

Complete protection seemed to favour the regeneration of thorn bush. In protected plots *Acacia* thorns were rather numerous and fairly tall. Cattle grazing stimulated regeneration of the thorn bush. After three years of treatment all plots grazed by cattle were densely covered with young *Acacia* 5–7 ft. in height.

Regeneration of Ol'Leleshwa was influenced only by mowing which arrested the development of young plants and kept them low and weak. Cattle grazing did not particularly encourage the growth of Ol'Leleshwa. As the goats only ate the leaves of the bush occasionally and unwillingly they did not suppress it to any considerable extent.

Another plant should be mentioned here, namely Sodom Apple (*Solanum incanum*) which is the main pasture weed of the area. It is a perennial herb with tall, much branched, prickly stems. Not unlike young thorn bush this plant interferes with grazing to a considerable extent. Sodom Apple was abundant in many plots. After three years of the trial it was very numerous in plots grazed by goats, in burnt plots and in plots under complete protection and less numerous in plots grazed by cattle. In plots mown twice a year Sodom Apple was very scarce.

GRASS COVER

At the beginning of the trial the herbaceous vegetation of the plots consisted mainly of grasses with an admixture of herbs which normally did not exceed ten per cent of the total herbage and only occasionally, mostly in places formerly under thick bush, was the proportion of herbs high. The grasses belonged to the following groups: tufted perennials, stoloniferous perennials, rhizomatous perennials, and the annuals.

Tufted perennials were particularly numerous in plots Nos. 1–10 and less numerous in plots 11–20. The main tufted perennial was *Cymbopogon pospischilii*, a grass of low palatability. *Themeda triandra* (Red Oat grass) and *Eragrostis superba*, although less abundant than the *Cymbopogon*, were also numerous. These two species are palatable. Other tufted perennials were: *Panicum maximum* (Guinea grass), *Sporobolus pyramidalis*, *Aristida adoensis*, *Hyparrhenia filipendula*, *Hyparrhenia lintonii*, and *Brachiaria brizantha*. *Harpachne schimperi*, a short-lived perennial, was also common.

Stoloniferous perennials were represented by two species of Star Grass: *Cynodon dactylon* and *Cynodon plectostachyum* which formed separate colonies; *Cynodon dactylon* being more abundant than *C. plectostachyum.* Star grass either formed dense, almost pure colonies, or was mixed with annuals or Couch grass.

Rhizomatous perennials were: *Digitaria scalarum* (Couch grass), *Sporobolus phyllothrichus,* and *Cenchrus ciliaris.* The last named formed only small, slowly spreading, pure colonies while Couch grass and the *Sporobolus,* both with longer rhizomes, formed larger colonies, often mixing with other grasses and only occasionally forming pure stands. Couch grass was much more prominent in the herbage than the *Sporobolus* and the *Cenchrus.*

Of the annual grasses *Aristida keniensis* (a local species closely allied to the widely spread *Aristida adscensionis*) was the most abundant and conspicuous species. Other common annual grasses were *Setaria pallidifusca, Chloris pycnothrix,* and *Eragrostis cilianensis.* The annuals grew either in pure stands or, more commonly, mixed with stoloniferous or rhizomatous perennials; they also grew between the tufts of perennial tufted grasses.

GRAZING PREFERENCE

When cattle entered a plot during the wet season they usually took the grasses in the following order: annual grasses—Couch grass—young growth of Star grass—more palatable tufted perennials (Red Oat grass and *Eragrostis superba*)—old Star grass—*Cymbopogon pospischilii.*

This was only a general trend and some exceptions occurred. In the dry season almost the same preference in grazing was observed except that Couch grass was usually preferred to the annuals and that the preference for certain grasses over others was much stressed and the grazing much more selective than in the wet season.

Goats normally preferred the leaves of thorn bush and also of some broad-leaved shrubs. They also ate to a certain extent the leaves of Sodom Apple and Ol'Leleshwa. Their next choice was annual grasses. Goats also picked up odd leaves of tufted perennials and flowering heads of the *Cymbopogon.* Star grass was usually left uneaten.

CHANGES IN GRASS COVER UNDER THE TREATMENTS

During three years of the trial the grass cover of the plots underwent certain changes which were connected partly with the natural change of vegetation ("succession") of cleared land but chiefly with the treatments used in the trial. The changes were recorded in the form of general observations made by the author and by Messrs. R. A. Langridge, Assistant Agricultural Officer, Kisokon, I. A. McLeod, Assistant Agricultural Officer, Kabarnet, and R. N. Edmondson, who were in turn in charge of the trial. Apart from the general observations, changes in the grass cover were recorded in permanent belt transects 50 ft. long and 1 ft. wide, two transects in each plot. In the transects the position of the following was recorded: (*a*) individual tufts of perennial-tufted grasses; (*b*) colonies of Star grass, Couch grass, *Sporobolus phyllothricus* and *Cenchrus ciliaris;* (*c*) colonies of annual grasses; (*d*) mixed colonies of perennial spreading grasses and the annuals; (*e*) young plants of trees and shrubs; and (*f*) individual plants of Sodom Apple. Transect readings were done in October, 1948, at the beginning of the experiment, and in January, 1952, after the treatments were discontinued and the plots rested in November—December, 1951, when exceptionally good rains occurred. The results of transect readings are discussed later in this article.

Cattle Grazing

The effect of cattle grazing on the grass depended on the system and the season of grazing. Continuous grazing of 5 head in a 5-acre paddock—a high density for the area—kept all grasses permanently down and the soil was rather bare during the most part of the year. During the wet season cattle continually removed fresh growth of grass and what was left towards the end of the season was consumed completely in the following dry season. If the rains were poor and the dry season long, as in 1950, the cattle had to be removed for a considerable period of 26 weeks due to lack of grazing. Annual grasses had been eaten before they had a chance to produce seed. Almost all grass species in this plot were equally well eaten; even *Cymbopogon pospischilii* was grazed low and only the tufted bases 2–3 in. high were left uneaten. A considerable amount of unpalatable annual herbs (chiefly *Coleus comosus*) invaded the bare ground of the plot. After the plot was given a rest in October–December, 1951, the grass recovered and the plot was covered with even, though rather low, Star grass and fresh green tufts of tufted perennials (chiefly *Cymbopogon pospischilii* and Red Oat grass), with only a small proportion of annual grasses. There were no mature or dead grasses present. In general, after the rest, this plot produced better grazing than any other plot in the trial. It is believed, however, that if the same severe treatment continued for another few years it could produce a disastrous effect on the grass cover.

Incidentally, numerous tufts of Red Oat grass were observed in this plot after three years of the treatment. This is notable since it is generally believed that Red Oat grass cannot withstand heavy grazing.

The effect of less heavy continuous grazing, with two head of cattle in a 5-acre plot, was different only in degree. The soil in this plot was usually less bare during the grazing, the grass was kept low but not all species were eaten equally well. Older Star grass and tufted perennials, particularly *Cymbopogon*, were often only slightly grazed. The annual grasses had a better chance to produce seed. During the dry season of 1950 the cattle had to be removed from this plot for 16 weeks. At the end of the trial, after a rest, the grass in this plot recovered well and produced grazing of almost the same quality as that from under heavier continuous grazing.

Under the wet season grazing all grasses were grazed fairly evenly. Annuals, Star grass and tufted perennials were eaten well except the *Cymbopogon* of which 6–12 in. were left ungrazed. The annuals were eaten before seed setting. After grazing the plot was left only slightly less bare than the plot of continuous heavy grazing. At the end of the trial, after a rest, the grass recovered and the plot had large patches of Star grass and numerous green and fresh tufts of tufted perennials. The proportion of annuals was not high. In general the plot looked rather similar to that of lighter continuous grazing.

Grazing in the dry season was more selective. Couch grass, annual grasses and one season's growth of Star grass were eaten much better than tufted perennials and the old growth of Star grass. *Cymbopogon* was practically untouched. Annual *Aristida* was grazed bare in spite of being dead and dry. After grazing the plot looked much less bare than the plots of continuous and wet season grazing because of a large amount of coarser grasses left ungrazed. However, the places which before grazing were covered with annuals, Couch grass, and young Star grass were quite bare and the grass cover of the plot looked very uneven with tall tufts and colonies of coarse grasses and bare places between them. At the end of the trial, after a rest, the grass in the bare places recovered but the plot still looked untidy and patchy with a large amount of dead or mature coarse grass, some fresh growth of Star grass and tufted perennials, and abundant *Aristida* in formerly bare places.

The plot under alternate dry and wet season grazing was grazed only twice, the second time being in the wet season of 1950. Having been untouched for more than a year before the end of the experiment, the grass consisted finally of a large amount of dead and mature grass with some fresh growth of tufted perennials and Star grass and with patches of annual grasses.

The plot under annual dry season grazing and wet season grazing once in three years was grazed during the dry seasons of 1949, 1950 and 1951 and also in the following wet season of 1951. During the first three grazings (dry season) the grass was grazed in the same way as in the plot of the dry season grazing. After grazing the plot looked untidy and patchy with mature or dead *Cymbopogon*, colonies of tall, coarse Star grass and numerous bare places, which, after a rest in the wet season developed some fresh growth of perennials and abundant *Aristida*. However, after grazing in the wet season of 1951 much of the dead and mature material almost disappeared and after the final rest the plot produced fairly good grazing.

The number of acres per head per year in plots grazed by cattle ranged from 1.3 to 2.4, the latter figure being for the plot of alternate dry and wet season grazing which was by no means overgrazed. A normal density of grazing for this type of grassland can be roughly estimated as about 2.5 acres per head of small native cattle. For the European cattle of the normal size this figure should, probably, be doubled. This density of grazing can be referred only to those parts of the Kisokon and Esageri and of the adjacent Rongai area where good, unspoiled herbage of perennial grass still exists.

Goat Grazing

In eight plots various types of goat grazing were tried ranging from two to six animals per acre per year and from ten to 100 animals at a time. All these treatments produced a similar effect on the herbage. As already mentioned, the goats preferred the leaves of thorn and other bush to the grass, eating the grass only to a limited extent. Although the goats did eat grasses, preferably annuals and also odd leaves and flowering heads of many perennials, they did not produce any marked effect on the grass cover. Even after a plot had been heavily stocked with goats a large amount of grass was always left ungrazed. A more marked effect on the herbage, particularly in heavily stocked paddocks, was due to trampling. The goats made numerous paths which were trampled bare. They also created bare ground in places where they camped, especially in the front part of the plots, nearer to the entrance gate.

Goat grazing, not unlike complete protection, resulted in accumulation of dead and mature grass which looked patchy and untidy. This was accentuated by numerous paths and bare camps, particularly in heavily stocked paddocks. After the final rest the untidy and patchy appearance, with dead and mature grasses and the annuals covering formerly bare places, was still observed.

Complete Protection

Two plots were protected and not subjected to any treatment. This resulted in the accumulation of dead and mature material of all grasses. During three years of the trial no significant change in the proportion of various groups of grasses was observed.

Burning

Two plots were burnt three times: in March, 1949, in February, 1950, and in November, 1950. Between the burns the grass had time to recover. However many bare places were observed in a dry year (1950). At the end of the experiment the herbage in the burnt plots was in much the same state as in 1948 with Star grass and *Aristida* as the main components. Only the proportion of Couch grass slightly increased. Tufted perennials were scarce in these plots from the start.

Mowing

Two plots were mowed twice a year—in the middle and at the end of the rainy season. Two cuts a year kept Star grass permanently low. This grass and tufted perennials, particularly *Cymbopogon,* recovered rather slowly after cutting and the *Aristida,* which recovered quickly if cut when young, was often very conspicuous although its actual proportion in the herbage was lower than it appeared to be. Tufts of the *Cymbopogon* were smaller than in other plots, probably weakened by periodical cuttings in the growing season. The number of tufts of Red Oat grass and its proportion in bulk increased considerably towards the end of the experiment. In general ,after three years of the trial the herbage was free from dead or over-mature grass and looked tidy and uniform. This impression was stressed by the absence of young thorn bush and the Sodom Apple. However, the grass of the mown plots lacked vigour probably due to lack of manuring by animal droppings.

TRANSECT READINGS

Final transect readings indicate that the area and, in many instances, the position occupied by tufted perennials, spreading perennials and the annuals had not been essentially changed during the three years of the trial. Of the changes recorded in the transects very few could be related to the treatments. Even under treatments such as continuous grazing of cattle at a rate of one beast per acre, which kept the ground bare for a considerable time, the proportion in space occupied by the main species and types of grasses remained virtually unchanged. Perennial grasses retained their potential vigour and were not destroyed by the intense grazing and the differences observed visually during the experiment were only of a temporary nature. It can be expected, therefore, that under quite a variety of treatments the perennial grass of the type existing at Kisokon may remain comparatively unchanged for a considerable time.

The following notes refer to the main grass types and species recorded in the transects.

The number of plants of perennial tufted grasses slightly increased in some plots and decreased in others during three years of the trial but no clear correlation with the treatments was observed. In general, the number of tufts increased by approximately one in ten and the following was the number of tufts observed in October, 1948, and January, 1952:—

	Number of tufts recorded in 1948	Number of tufts recorded in 1952	Number of the same tufts found in 1948 and 1952	Number of tufts which died since 1948	Number of new tufts recorded in 1952
Cymbopogon pospischilii ..	290	333	177	113	156
Themeda triandra	98	125	49	49	76
Eragrostis superba	81	56	25	56	31
Other species ..	83	88	28	55	60
Total for all species	552	602	279	273	323

As about 50 per cent of the tufts died during the three years of the trial and were replaced by the new plants, it can be suggested that the average length of life of the tufted perennial grasses prevailing in the experimental area may be around six years.

During the trial pure colonies of Star grass retained or only slightly changed their position. In places where Star grass grew mixed with annuals or with Couch grass it changed its position considerably, disappearing in some areas and emerging in others, mostly with no clear correlation with the treatments, although, in general, the areas occupied by Star grass mixed with annuals slightly decreased in plots grazed by cattle and increased in plots grazed by goats or protected from grazing.

The space covered with Couch grass decreased slightly in most plots, more so in plots grazed by cattle. The space occupied by *Sporobolus phyllothrichus* in most cases decreased, probably due to the clearing of bush as this grass grows mostly in light shade. Colonies of *Cenchrus ciliaris*, although fairly stable, tended to decrease slightly under cattle grazing and to increase under goat grazing.

The space covered by the annuals, pure or in mixture with spreading perennial grasses in most cases slightly increased.

SUMMARY OF RESULTS

The main findings of the trial can be summarized as follows:—

1. Goat grazing, burning and mowing suppressed regeneration of thorn trees and shrubs, complete protection resulted in a moderate rate of regeneration while cattle grazing stimulated the regeneration of thorn bush.

2. Cattle and goat grazing and burning did not suppress the regeneration of Ol'Leleshwa. Mowing arrested temporarily the growth of this bush which, however, began to recover as the treatment was discontinued.

3. Sodom Apple was very little affected by any treatments except mowing. The mown plots were actually free from this weed.

4. Heavy continuous grazing of cattle during three years kept the grass low and the ground was often almost bare. After a rest the grass recovered and produced good grazing. Less heavy continuous grazing produced similar, though less marked effect.

5. Cattle grazing in the wet season also kept the grass low and after a rest resulted in reasonably good grazing.

6. Cattle grazing in the dry season resulted in accumulation of old, mature grass and produced eventually somewhat inferior grass cover.

7. Goat grazing resulted in accumulation of dead and mature material as the grass has been eaten only very slightly. The goats created numerous paths and bare campling places thus producing an adverse effect on the herbage.

8. Complete protection resulted in accumulation of dead and mature grass and did not produce any beneficial effect on the herbage.

9. Mowing produced uniform and low grass which, however, lacked vigour.

10. Transect records showed that the initial position and the space occupied by the main types and species of grasses only slightly changed during the trial. Perennial grasses retained their position and potential vigour even under severe treatments.

11. A normal, safe density of grazing for the type of grassland existing in the experimental area can be roughly estimated as about 2.5 acres per head of small native cattle or about 5 acres per head of the full-size native cattle.

12. The conclusions listed above refer specifically to the area under trial or to similar areas of Kisokon, Esageri and adjacent parts of the Rongai area where there is a good, unspoiled cover of perennial grass. They do not relate to the devastated and eroded portion of the Baringo district.

ACKNOWLEDGMENTS

The author records his sincere thanks to Dr. E. D. Bumpus, Senior Pasture Research Officer, Kenya, and Mr. J. O. Green, Senior Research Officer, Grassland Research Station, Hurley, England, for very valuable advice during the preparation of the manuscript and to Messrs. R. A. Langridge, I. A. McLeod, and R. N. Edmondson for field observations during the trial. Thanks are also due to the Director of the East African Meteorological Department for the rainfall records.

NOTE ON PUCCINIA POLYSORA RUST OF MAIZE IN KENYA

By R. M. Nattrass, Department of Agriculture, Kenya

(*Received for publication on 12th February, 1954*)

In a preliminary note in this JOURNAL (Nattrass, 1952) on the occurrence and appearance of *Puccinia polysora* on maize in Kenya, the disease was described and illustrated as very closely crowded pustules occupying large areas of the upper leaf surface. In all the previous severe attacks of the disease seen, the pustules were evenly distributed, and so densely crowded as to be in contact with one another.

A type of occurrence which does not conform to the above description has been observed in a number of recent collections. This takes the form of generally rectangular oblong spots running parallel to the leaf axis and bounded on the long sides by the larger veins. The spots, which are infrequently rounded, vary little in size, being in the neighbourhood of ½ to 1 cm. in length and the width of the interveinal area. They are separated longitudinally from each other by a few millimetres, but some occupying the same interveinal area overlap at the ends with an imbricate effect but are rarely truly confluent.

On the upper surface each spot bears typical *polysora* uredo pustules, from six to twelve in number according to the size, with an indication of the usual central pustule and concentric satellites. On the lower surface the pustules are not so numerous and are in a somewhat earlier stage of development. Whereas the pustules on the upper surface may be open, those on the under surface may all be closed.

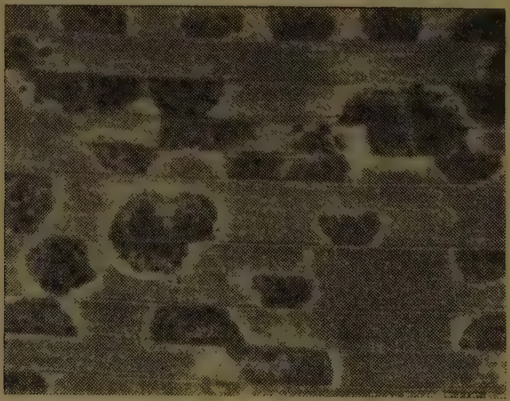
The term "leopard spot" used in connexion with this type of symptom is descriptive and indicates the wide divergence from the more common overall "powdering" effect previously described.

Inoculations from the original material onto maize seedlings in the greenhouse reproduced a series of similar spots with large central pustules and concentrically arranged satellites but with less pronounced rectangular outline.

This suggests that the larger veins, while constituting no barrier in the young plant, do so as the leaves become older.

REFERENCE

Nattrass, R. M. (1952). Preliminary notice of the occurrence in Kenya of a rust (*Puccinia polysora*) on maize. *E.A. Agric. J.*, XVIII, 1, 39.



"Spotted" symptom of Puccinia polysora. On maize × 2

EFFECTS OF AMMONIUM AND NITRATE NITROGEN ON A TEMPORARY MOLASSES GRASS PASTURE

By **H. W. Dougall, Department of Agriculture, Kenya**

(*Received for publication on 9th February*, 1954)

In 1936, Lewis [1] reported that when perennial rye grass is grown in a sand-bentonite medium [2] of pH 7.61, any nitrate absorbed by the plant from sodium nitrate is less effective in increasing yields of dry matter than ammonium nitrogen from sulphate of ammonia. Also, the percentage phosphoric oxide content of the grass is lower with the nitrate fertilizer than with the ammonium fertilizer. Similar results were obtained last year on our Grassland Station at Kitale, when the same two fertilizers were compared in a field experiment on a temporary molasses grass pasture, established two years ago in a coarse, sandy loam soil of pH 5.8. Nitrate of soda and sulphate of ammonia were applied to the pasture at rates equivalent to 18 lb., and 36 lb., N per acre, a basal dressing of double superphosphate, providing the equivalent of 80 lb., P_2O_5 per acre, having first been applied. All treatments were replicated five times.

The data given in Table I show that the nitrogen content of molasses grass increases with the amount of nitrogen applied, and corresponding amounts of ammonium and of nitrate nitrogen produce almost identical values for percentage nitrogen contained in the herbage. Clearly, the grass makes better use of ammonium nitrogen, since yields of dry matter are significantly higher with sulphate of ammonia than with nitrate of soda.

The percentage P_2O_5 content of the herbage is increased significantly by both nitrogenous fertilizers. There is no significant difference between the two forms of nitrogen, although as Lewis reported, ammonium nitrogen gives slightly higher P_2O_5 values than nitrate nitrogen.

Soil reaction values were determined before fertilizers were applied and after the grass was harvested. After harvesting, the nitrogenous fertilizers were again applied and pH values were determined late in November, that is, nearly six months later. Results of all determinations, which are given in Table II, show an increase in acidity with the ammonium fertilizer and a decrease with the nitrate fertilizer.

Reduction in pH due to sulphate of ammonia has been reported previously [3] and the cause is explained theoretically by Russell [4]. It is somewhat surprising that such a reduction occurs during a period of six weeks from the time the fertilizer is applied. Concomitantly, during this time, there is a slight rise in pH due to nitrate of soda. This might be anticipated in light of Russell's explanation that as NO_3 ions are taken up by the plant, Na ions will be left in the soil and are free to exchange with calcium. Further, some of the fertilizer sodium, as it washes through the soil, may be expected to change with calcium in the exchange complex.

This difference in the behaviour of the two fertilizers in regard to pH has been used by different workers to explain why, under certain conditions, P_2O_5 uptake with ammonium nitrogen is greater than with nitrate nitrogen. For example, Lorenz and Johnson [5] growing different crops in a fine sandy loam Californian soil with paste pH values of 7.2–7.8, have shown that ammonium fertilizers provide greatly increased yields over nitrate fertilizers in semi-arid conditions. They demonstrated that the physiologically acid sulphate of ammonia effectively releases native soil phosphorus from light slightly alkaline calcareous soils, but sodium nitrate does not. When sulphur or large amounts of phosphorus were added to the soil, however, they found that nitrate fertilizers can be as effective as ammonium fertilizers. Gericke [6] showed that with adequate phosphorus supply, yields are higher with nitrate than with ammonium nitrogen, but with inadequate phosphorus, ammonium nitrogen is superior. These differences are observed in sand and water cultures and therefore have a physiological origin, and are unconnected with the "mobilizing" of soil phosphate by nitrate and ammonium ions. Pirschle [7], cited by Lewis [1], showed that in water cultures maintained at constant pH, ammonium assimilation in a number of crops is associated with greater phosphate uptake, and nitrate assimilation with greater potash uptake. Lewis himself did not consider that the differences which he found in the P_2O_5 uptake by perennial rye grass could be ascribed entirely to differences in physiological reaction of the nitrogenous fertilizers, but rather to a direct relationship between uptake of ammonia and of phosphorus.

There is evidence to show that grass can take up ammonium ions direct, that is, without nitrification [8], and it is possible that in the Kitale soil, where the medium is moderately acid, more active growth is promoted by direct uptake of ammonium than by nitrate ions, and a correspondingly greater demand is made for available soil and fertilizer phosphorus. Evidence to clarify this point is to be sought this year.

REFERENCES

[1] Lewis, A. H. J. Agric. Sci., Vol. 26, 1936.

[2] Greenhill, A. W., and Page, H. J. J. Agric. Sci., Vol. 23, 1933.

[3]Dougall, H. W. *E.A. Agric. J.*, Vol. 19, 1954.

[4] Russell, Sir E. John. Soil Conditions and Plant Growth, Longmans, London, 1952.

[5] Lorenz, O. A., and Johnson, C. M. Soil Science, Vol. 75, 1953.

[6] Gericke, S. Bodenk. Pfl Ernähr, Vol. 20, 1940.

[7] Pirschle, K. Bodenk. Pfl Ernähr, Vol. 22B, 1931.

[8] Richardson, H. L. J. Agric. Sci., Vol. 24, 1934.

TABLE I.—YIELDS OF HERBAGE AND PERCENTAGE AND P_2O_5 CONTENT

FERTILIZER	TREATMENT MEANS				
	Nitrogen (per cent of dry matter)	Yield of Dry Matter (tons per acre)	P_2O_5 (per cent of dry matter)	Yield (lb. per acre)	
				Crude Protein	P_2O_5
None	1·151	1·13	0·44	181	11
Nitrate of Soda—18 lb. N per acre	2·120	1·68	0·56	497	21
Nitrate of Soda—36 lb. N per acre	2·640	1·30	0·58	479	17
Sulphate of Ammonia—18 lb. N per acre	2·249	2·06	0·64	647	29
Sulphate of Ammonia—36 lb. N per acre	2·681	1·92	0·61	720	26

	Yield of Dry Matter	Per cent. P_2O_5 content of Herbage
S.E. of difference between Control and Treatments	0·176	0·042
S.E. of difference between 2 Treatments	0·203	0·048

TABLE II.—MEAN pH VALUES

DATES OF SAMPLING FOR pH	FERTILIZER				
	None	Nitrate of Soda (lb. per acre)		Sulphate of Ammonia (lb. per acre)	
		18	36	18	36
19 May—before applying fertilizer	5·80	5·76	5·72	5·87	5·67
30 June—after harvesting the grass	5·82	6·22	6·26	5·27	4·94
28 November—6 months after re-applying N	5·57	6·09	6·18	5·06	4·40

CERCOSPORA LEAFSPOTS OF GROUNDNUTS IN TANGANYIKA

By J. S. Hemingway, Plant Pathologist, Overseas Food Corporation

(*Received for publication on 19th February, 1954*)

The areas farmed by the Overseas Food Corporation in Tanganyika are at Kongwa in the Central Province, Urambo in the Western Province, and Nachingwea in the Southern Province. Full details of the climatic and other conditions of these areas are to be found in the annual reports of the Corporation (1, 2 and 3). In each of the three areas the leafspots here described cause heavy losses in yield, both directly, through the parasitic activity of the fungi, and indirectly through harvesting difficulties.

The two species of the fungal genus *Cercospora* which attack groundnuts are *Cercospora personata* (Berk. and Curt.) Ell. and Everh. and *C. arachidicola* Hori. The fungi have perfect stages *Mycosphaerella berkeleyii* W. A. Jenk. and *M. arachidicola* W. A. Jenk. respectively, but these have not been recorded in East Africa. The symptoms, patterns of incidence, and effects of the two pathogens on their host are very similar.

The lesions on the leaves are at first circular, later tending to become angular where their growth reaches major veins. They are dark brown to near-black in colour. The spores are produced on dark cushions of conidiophores, mainly on the underside of the leaf in the case of *C. personata*, but on both surfaces with *C. arachidicola*. The central, sporulating part of the lesion varies between 2 and 5 mm. in diameter: there is a yellow to pale green halo around each lesion, up to 2 mm. across. When sporulating is occurring, necrosis begins in this halo and spreads rapidly to affect up to a quarter of the leaflet lamina: if the lesions are numerous there is coalescence of the necrotic patches, rapidly followed by fall of the leaflets.

When the incidence of this disease is heavy, lesions originate on the petioles and on the stems. These lesions spread very rapidly along the petioles and gradually girdle them, leading to shedding of the entire leaf. The presence of stem lesions, interrupting translocation along the laterals, accelerates maturity, and death occurs when almost all leaves have fallen.

The incubation period from infection by the spore to appearance of a pin-head lesion is six to seven days on susceptible varieties, and sporulation begins, during periods of high humidity, some four to six days later. Sporulation continues actively until the death and fall of the leaflet. Immense numbers of spores can be spread over long distances by wind, and locally by rain splashes. Insect distribution, mainly by grasshoppers (internally) and leafhoppers and beetles (externally) is common in America [6], but high insect populations, excepting *Aphis craccivora* Koch., the vector of Rosette disease, have not been found on the groundnut crop in Tanganyika.

EPIDEMIOLOGY

A very few lesions of *C. personata* were found on the first plantings of groundnuts at Kongwa in 1948 [1]. In the 1949 season [2] the incidence at Kongwa was again recorded as slight, with little defoliation: *C. personata* was also recorded at Nachingwea. Both species were identified at Urambo, late in the growing season. The origin of infection can be ascribed to wind-borne spores spreading from infected native plantings: inspections of such plantings in the vicinity of each of the three areas has invariably revealed the presence of both species of *Cercospora*.

In the 1950 season [3] the disease was again slight at Nachingwea. At Kongwa and Urambo, however, epidemics caused extensive leaf-fall on most plantings towards harvest-time. In both these areas volunteer groundnut plants had persisted through the dry season—very many at Urambo and a few on low-lying soils at Kongwa. Other volunteers germinated after the first rains: on these the disease built up rapidly and then spread to the later-planted crop: sample transects showed no evidence of any spread from the bush.

In the 1951, 1952 and 1953 seasons, in the Kongwa and Urambo areas, and in the Nachingwea area as the extent of ground cultivation increased, the epidemics proved most serious. Defoliation often began at the age of 55–60 days, and in many instances was complete by 80–90 days. The main variety grown was "Natal Common", with a growth period of 100–110 days. Excepting that the common species at Urambo is *C. arachidicola*, whereas at Kongwa and Nachingwea it is *C. personata*, the epidemiology is similar in each area; and the only difference in the mode of dry-season persistence of the diseases is that there are very few volunteer plants alive throughout that season at Kongwa.

The origins and build-up of the epidemic infection have been studied throughout the year. The modes of carry-over of the disease from one season to the next are on volunteer plants, in crop residues and the soil, and on the seed.

Volunteer Plants in the Dry Season

Seed of the variety "Natal Common" shed during harvesting will germinate at once if sufficient moisture remains in the soil, or if the moisture content is increased by an out-of-season shower. In the drier area of Kongwa, large numbers of volunteers are rare, but at Nachingwea and Urambo, volunteer populations of 20,000 plants or more to the acre are common.

These dry-season volunteer populations are gradually reduced during the dry season by lack of water and by termite activity. This is particularly the case at Kongwa, where the groundnut crop is usually not due for harvest until after the end of the rains. In the rare cases where large numbers of post-harvest volunteers have been found, their numbers decreased during the dry season to a very low level. At Nachingwea, although there is often a considerable reduction by these agencies, there is invariably a number which are able to exist until early rain causes renewed growth. At Urambo, and on some of the lower-lying fields at Nachingwea, the volunteers do more than merely exist: they flourish, flower, and set seed effectively, thus increasing the number of seed lying ungerminated. Although the growth of the host plants is very reduced during the dry season, some lesions of both species of *Cercospora* can always be found. The fungi do not sporulate actively in the low atmospheric humidities, nor can the spores germinate to infect so easily, so that lesions are not found extensively over the foliage. With the smaller number of lesions there is rarely much leaf-fall of these volunteers.

But when, with the early rains, the growth of the host plants is renewed, the existing lesions sporulate and spores spread to infect the new foliage, and that of newly germinated volunteers. Thus the level of infection, which has remained low through the dry months, begins to increase and inoculum is present at a high level when the new crop is planted: hence the epidemic on the crop commences early in its life. The spread of infection from volunteer plants was demonstrated at Kongwa in 1951. A large area of "*mbuga*" on one farm, which had previously been cropped with groundnuts was designated as a soil conservation drainage area, and the volunteers were not destroyed. (An "*mbuga*" is a flat low-lying area of natural grassland, possibly formed by the silting-up of a drainage valley or lake bed.) Adjacent to this area a number of parallel fields were planted with groundnuts: counts of lesions of *C. personata* made one month and six weeks after planting showed a gradient of infection away from the volunteers in the "*mbuga*". The survey was discontinued when the heavy incidence began which indicates spread within the crop.

Persistence of Infection in Crop Residues and in the Soil

Diseased leaves fall from the plant during its growth, and there is a complete shedding of leaves and petioles of a seriously attacked crop. A large number when blown about by the wind come to rest between ridges, or lodge in weed or grass growth. Some of the leaves are partly buried during harvesting and most of those on the surface are lightly covered during any cultivation for volunteer elimination. The great majority of the leaves are soon destroyed by termites, excepting on soils where the termite activity is low, such as the "*mbugas*" at Kongwa.

The bulk of the aerial parts—the stems and peg attachments, with some or most of the petioles and some of the leaves, according to the severity of the attack—are left after threshing on the sites of stooks, or in large heaps when the crop has been carted to a stationary thresher. The stems cannot be buried by light discing, and are only slowly reduced by termites.

It appears that the *Cercospora* mycelium can persist in a dormant state for at least six months: a number of the lesions on residue samples taken during the dry season will sporulate after four to five days at a high humidity [5]. Thus undestroyed diseased residues serve as a passive dry-season host for the pathogens.

There are strong indications that viable inoculum can persist in the soil. The form of the inoculum can only be presumed to be conidia, as no other type of spore-body has been observed under any conditions. If groundnuts are planted a second year in succession, they are attacked by *Cercospora* at an early stage. Lesions can be found in large numbers as early as ten days after germination, and, as the incubation period of the fungus is seven to eight days, the infections must have been made as each leaf opened. Later, all the lower leaves of such plants bear immense numbers of lesions, which would appear to have originated in rain splashes from the ground.

An experiment on the control of this persistence in residues and in the soil was carried out at Kongwa in 1952. There were three blocks: the control had not been cropped with groundnuts in the previous season, the second had all possible groundnut residues removed, while on the third all residues were left *in situ* after harvesting. A wide range of cultivation treatments, from deep double-ploughings after harvest and before planting to single discings, was followed by normal planting of groundnuts. By the tenth day after germination infection was heavy, and samples were taken for lesion counts. The results are shown in Table I, and demonstrate that no method of residue disposal or cultivation treatment gave a satisfactory control of persistent infection.

There is, as yet, no evidence of the length of time soil-borne persistence can last, but it is recommended that for adequate *Cercospora* control at least one year's interval should elapse between groundnut croppings, and preferably two years on soils of low biological activity.

Seed-borne Infection

Examination of the centrifuged washings of pods after harvest has shown the presence of large numbers of *Cercospora* conidia. Smaller numbers were found in the washings of kernels decorticated by hand or by machine [5]. The heavy spore-load of the pods obviously originates when the plants are stooked at harvest, and the pods are in close proximity to diseased tissues. Spores on the testas will have been transferred during shelling.

It seems unlikely that many conidia will survive during germination and until the remnants of the testa are carried up on the cotyledons to their post-germinant position above the ground. Portions of testa were found to be carried up in 33 per cent of germinations of "Natal Common" at the normal planting depth of 1½–2 in. Considering the facility of spread in any area, and the large numbers of spores which can persist in residues and soil, and be released from volunteers, this carriage on the seed is of minor importance.

EFFECTS

The incidence of the *Cercospora* epidemic affects the yield of the groundnut crop in two ways: directly, by the weakening of the host, and indirectly, as the early death of the plant is followed by termite and saprophyte invasion, leading to inefficiency of the harvesting operations.

The first effect on the plant is that increasingly large areas of the foliage are parasitized and killed by the fungus. This loss of photosynthetic tissue is enhanced when leaflet- and leaf-fall begins, although the plant continues leaf production. Finally, however, complete leaf-fall ensues, causing early death of the crop. This direct loss in yield has been measured by the comparison of plots carrying a natural infection with others where the disease had been completely controlled by "blanket" applications of sulphur dust, applied at three- to four-day intervals throughout the season: enough dust was applied each time to ensure a complete coverage of the foliage. The diseased and controlled plots were harvested on the dates when they seemed mature. The results are presented in Table II, and show that diseased plants produce significantly fewer pods, with an apparent tendency to lower pod weight, shelling percentage and oil content.

Plantings of groundnuts made late in the season are attacked at an early stage in their growth, as spores spread from established epidemics. The crop is younger when heavy leaf-fall begins and has to be harvested earlier than would a healthy crop. It was observed at Nachingwea (1952) that December-planted "Natal Common" reached maturity in 107 days, January-planted in 100 days and February-planted in 93 days. At Kongwa (1951) it was noted that heavy defoliation commenced after the following times:—

Date of planting.—11th January, 1951.

Age of crop at time of heavy defoliation.— 13 weeks.

Date of planting.—19th January, 1951.

Age of crop at time of heavy defoliation.— 11 weeks.

Date of planting.—10th February, 1951.

Age of crop at time of heavy defoliation.—10½ weeks.

Date of planting.—20th February, 1951.

Age of crop at time of heavy defoliation.—9 weeks.

Date of planting.—2nd March, 1951.

Age of crop at time of heavy defoliation.—7½ weeks.

A series of studies were made at Kongwa in 1950 on the accumulation of dry matter in the groundnut crop during its growth period. Those studies have been fully reported [3]. The formation of the shell of the pod was virtually complete at 78 days: thereafter further increase in the dry matter of the pods was confined to increases in the kernels. Kernels were first present at 64 days, and oil was then detectable. The peak period of kernel growth and oil formation was 78–92 days, but even after 92 days 31 per cent of the kernel weight was laid down, and the oil content continued to increase. The possible reduction in yield of the groundnut crop, which may be parasitized by *Cercospora* for most of its growth period, and often rendered moribund and killed by 80–90 days, is well evident.

When the early death of the crop occurs, digging operations should be started immediately, as termites and soil saprophytic fungi, principally *Rhizopus* and *Aspergillus* spp., begin to attack the plants even when moribund. The moulds are particularly active when the soil moisture is high, that is, when the crop has become "mature" before the cessation of the rainy season. When the plants are attacked, shedding of pods occurs. Later, all the underground tissues—pegs, roots and stem bases—decay, so that the plants cannot be harvested mechanically. Loss of leaves and petioles, and the brittle nature of the diseased stems, makes mechanical handling more difficult. Hand-pulling and extensive gleaning become necessary, and considerable losses ensue since all the pods cannot be gleaned. The loss of the aerial parts also makes stooking difficult, as the plants do not hold together so well, and in the absence of leaves the stooks are neither protected from rain nor from strong sunlight. The defoliation by the disease causes a most serious loss where the plants are required for hay or ensilage, in a mixed farming system.

Figures were obtained at Nachingwea (1952) showing the amount of shedding which takes place as *Cercospora*-infected plants become moribund and die. The observations were made on an experiment to ascertain the optimum date for harvesting "Natal Common", and to show the effects on yield of digging at several other dates. *Cercospora* infection began to be heavy at 66 days after planting and leaf-fall was severe by 80 days. At the first date of digging (85 days) all the lower leaves had been shed, but there were only a few stem lesions and the stems were green and strong. By the second date (91 days) only two to four leaves remained on each lateral, and stem lesions seemed more numerous. By 97 days a few dead plants were to be found and the number increased daily. The stems gradually became more blackened by lesions and weaker. Some sprouting of nuts was observed at 109 days and was quite common by 115 days. The results are presented in Table III: it is apparent that shedding of pods commenced after 97 days, and the recorded population fell as some of the dead plants broke up. The shelling percentage, reaching its maximum at 109 days, suggests that true maturity would be reached at that time.

Two other experiments (Kongwa and Urambo, 1951), investigating the effect of harvesting at different dates, show the continuing increment of yield until 109–114 days, and the order of the loss if digging were enforced earlier because of the *Cercospora* infection. The results of these experiments are shown in Table IV.

CONTROL MEASURES

Measures can be taken in the dry season against the carryover of active *Cercospora* infection on volunteer plants, and the persistence of the pathogen in residues and the soil.

The Elimination of Volunteers

There is some variation of habit and length of season within the longer-season varieties. The rejection of plants which are not true to type will lead to a more evenly maturing crop, thus facilitating harvesting and avoiding shedding from over-mature plants. Improved digging, handling and threshing techniques, and efficient gleaning, where necessary, will reduce the amounts of seed left in the ground.

Some reduction in numbers can be achieved by allowing cattle to browse in the fields during the dry season, but they do not seem to be especially fond of green groundnut plants, and even where all the leaves have been eaten away, the plant does not always die. Browsing wild animals can help in the same way. Small rodents do a certain amount of good in removing ungerminated seed, and attacking that germinating, often removing the cotyledons as they emerge, but they can, from dropped seed or a neglected store-place, establish a number of plants in an inaccessible or unnoticed place.

All fields bearing any substantial population of volunteers during the dry season should undergo some cultivation operation. The timing of this may be a little difficult in some seasons, to achieve the maximum effect. If it is too early, before all the ground moisture is dried out, or while there is still a chance of a late shower, some plants will survive: also if it is early it may preclude extensive gleaning. If it is too late in the dry season a few plants, although damaged, may persist to pass on infection, or the volunteers may have set seed. The aim is to achieve a complete break for the maximum length of time, and it appears that the optimum period for Nachingwea is late July and early August. Under more favourable soil-moisture conditions for volunteers, as at Urambo, several operations may be necessary.

A light discing to 1½–2 in. depth is sufficient to kill the plants, and the tandem disc harrow has been found to be more efficient and economical than a one-way disc cultivator. With the tandem disc, weights are usually needed to improve penetration of any compacted patches. In one trial at Nachingwea, on a very uneven surface, a weighted tandem disc harrow reduced the volunteer population from 16,240 to 825 per acre. The elimination can of course be done in a dry-season ploughing or discing where such work is a normal practice. It is essential that complete coverage of the field is obtained: small patches of undisced plants may persist at the edges and headlands of fields, or where successive runs of the disc have failed to overlap. Numbers of volunteers are often to be found on the sites of stooks, and it is a great help if at harvest the stooks are arranged in a few rows along the field, or adjacent to contour banks: then a double run of the disc can easily be made, or hand-labour conveniently employed to deal with the volunteers.

A promising method of control now under trial is in the use of varieties whose seed has a dormant period. This factor is discussed under "Varietal Resistance".

One further group of volunteers requires mention: those germinating with the early rains, after the dry-season ones have been killed. Once infection begins on these it can build up so as to be present at a high level by the time the young crop is established. As with the residues, all such volunteers should be eliminated before the new crop germinates: this will normally be done in the preparation of seed-beds for the following crop, but if such preparation is not to be made until after the groundnut crop has emerged, i.e., for a late-planted crop, or for a fallow, a special operation will be necessary.

In a similar way the disease can build up on an abnormally early planting so as to menace the main planting. It is much more desirable to obtain a concentration of planting date, with no excessive early or late fields.

Crop Residue Disposal

All threshing residues on the sites of stooks or in large stacks should be burnt as soon after threshing as possible, and definitely before the early rains commence. Leaves which have collected in grass growth, such as on contour banks, can be destroyed by firing.

Provided this burning of bulky residues is efficiently done, the only remaining diseased tissues will be the fallen leaves all over the fields. Any cultivation for volunteer control will help to cover these, but all old groundnut fields adjacent to new plantings should be deeply disced or ploughed, so as to bury all the remnants, before the new plantings have germinated.

In a mixed farming system the foliage after threshing is useful as cattle fodder. It is unknown whether the conidia of *Cercospora* can survive passage through an animal's gut and persist in manure, but as a precaution, such manure should not be applied to new groundnut fields.

Rotations

Groundnuts should never be cropped in successive years in the rotation, and it is preferable that two years should elapse between crops. They should be followed by a crop which can economically be kept clean of weeds (including late volunteers), rather than a fallow or a densely planted crop.

Fungicides

In America, the standard control of *Cercospora* is by fungicides, most commonly sulphur dust. There, of course, protection of the crop gives a double dividend in increased yields of nuts and of hay. From the literature it does not appear that the disease is as serious in America as it is under comparable farming conditions in Tanganyika: references to complete defoliation and early death are rare.

Trials of fungicidal materials, both dusts and sprays, were made at Urambo in the 1951 season, and at Kongwa in the 1951 and 1952 seasons. Thirty-two materials in all were tested on observation plots: the control exercised by each material was measured by lesion-counts on samples taken at frequent intervals after treatment. Generally, sulphur-based sprays and dusts gave "excellent" control and copper-based ones "good" control. After further testing it was obvious that dusts were giving better control than sprays, because with the techniques used their coverage was better. Consequently sulphur dust was chosen and used in "blanket" experiments to measure the loss in yield due to the disease. Two such experiments were carried out at Nachingwea (1953), one on "Natal Common" and one on "Mwitunde" variety, growing in adjacent panels and so under comparable conditions. Sufficient dust was applied to give complete coverage of the foliage of the treated plots at four-day intervals, or oftener if heavy rain had fallen. Complete control of the disease was achieved: the incidence on the untreated plots was only moderately severe. The reductions in yield of 165 lb. kernels per acre of "Natal Common" on a disease-free yield of 699 lb. kernels per acre, and 80 lb. "Mwitunde" on a disease-free yield of 1,058 lb., were not significant, but the lower loss by the "Mwitunde" is a further indication of its character of resistance to the disease.

Another "blanket" experiment, under more severe disease incidence, is described under "Effects": in that case the loss of 338 lb. kernels per acre was significant.

In experiments at Urambo, using Bordeaux-mixture spray, significant yield increases of 132 and 169 lb. kernels per acre were achieved with a single application of spray, although by harvest leaf-fall was heavy on all plots.

There are several outstanding arguments against the economic use of fungicides against this disease in these areas. The first is the present low average yield of groundnut plantings: a considerable crop return would be required to cover the cost of the necessary applications. On practical, let alone economic, grounds, the use of water for large-scale spraying would be impossible; on the other hand, the persistence of a foliage dust against local weather conditions is very low. A storm of half an inch of rain, or more, can be considered to have removed all effective dust deposits. Again, the groundnut plant grows very rapidly: throughout the season there is an average increase of one leaf per day per plant, in a normal population, and over the period of setting pegs—40–60 days in age—the rate is much higher: consequently there is a rapid increase in the area of unprotected foliage, so that frequent applications are necessary. Whereas in the United States a schedule of three dustings at 10–14-day intervals, starting at 45–50 days, is effective [4], with the early start of the epidemic here dusting would be required to start at 40 days and be continued at weekly intervals at least, to ensure adequate protection of the crop. Again, it has been found that *Cercospora* spores can infect both upper and lower surfaces of the leaves, as well as petioles and stems, so that a very complete fungicide coverage, requiring a most intricate and efficient application technique would be required.

Varietal Resistance

In the 1950 season at Kongwa, it was observed that the short-season varieties of groundnuts appeared to suffer more defoliation than the longer-season types. In an attempt to select the varieties which in this way showed some resistance to *Cercospora*, the whole groundnut variety collection was scored in the 1951 season, a total of 73 varieties being examined in observation plots and replicated variety trials. They were assessed visually on several occasions during the season, for the degree of incidence of *Cercospora*, and later for the extent of leaf-fall induced. The varieties were classified as:—

Very susceptible	10
Susceptible to very susceptible ..	2
Susceptible	31
Tolerant	5
Some degree of resistance	25

In 1952 those varieties selected as having "Some degree of resistance" were planted together, with "Natal Common", the standard production variety, assessed as "susceptible", for comparative observation. The scorings were again made visually, at 7–10-day intervals throughout the season, and the varieties were graded as:—

Very resistant	4
High resistance	4
Medium resistance	8
Some resistance	9

The four "Very resistant" varieties all have dark-green foliage. "Kanyoma" has a semi-bunch habit and a growth period of 110–120 days, "Matevere" and "Kutambaa No. 1" are semi-bunch types, of 120–130 days growth, and "H.G.1" is a bunch type of 110–120 days. Of these, "Kanyoma" has been selected for extensive trials, and "H.G.1" for bulking up for trials.

The variety "Mwitunde" was not available for trial at Kongwa but was observed at Nachingwea to be resistant to *Cercospora* infection. As it is a most useful production variety, it is under detailed observation together with "Kanyoma" and "H.G.1" and selection work is proceeding.

A promising method of control of post-harvest volunteers is by the use of varieties whose seed has a dormant period. A number of varieties are known to possess this dormancy factor: they tend to be the longer-season (110–130 days) types. Tests with seed of the varieties "Kanyoma" and "Mwitunde" showed that less than 10 per cent germination was possible under optimum conditions until ten weeks after harvest, and that maximum germination could not occur until 18 weeks. Under normal field conditions, after the initial period of ten weeks, insufficient soil moisture would remain for germination to occur.

SUMMARY

The incidence of leafspots of groundnuts caused by *Cercospora personata* and *C. arachidicola* has reached severe epidemic proportions on large acreages planted in the Central, Western, and Southern Provinces of Tanganyika. Heavy losses have been caused by the defoliation and premature death of many plantings, and mechanized harvesting operations made difficult.

The pattern of incidence of the disease, with the origins of the epidemic cycle on volunteer plants living through the dry season, on crop residues and in the soil, have been studied. Effective measures for the control of these infection sources have been formulated, and the further practice of these control measures should reduce the losses incurred to a low level. There are good possibilities of development of resistant varieties of suitable habit for mechanized production; this development is proceeding.

The recommended control measures are:—

(1) *Rotation.*—No field should be cropped with groundnuts until a two-year interval has elapsed since the last cropping.

(2) *Residues.*—All combustible residues should be collected into heaps and burnt by the middle of the dry season. All residues remaining on fields should be buried by discing or ploughing before the germination of the new crop.

(3) *Volunteers.*—All volunteer populations of over 1,000 per acre should be disced by the middle of the dry season, and volunteers on headlands, etc., destroyed. Volunteers germinating with the first rains should be destroyed before the germination of the new crop.

ACKNOWLEDGMENTS

I am indebted to Dr. A. H. Bunting (formerly Chief Scientific Officer) and to Dr. A. C. Evans (Experimental Research Officer, Nachingwea) for their direction of my work, on behalf of the Overseas Food Corporation, and for constant advice and assistance. The observations at Urambo, and at Nachingwea prior to 1952 were made by Mr. I. A. S. Gibson and Mr. P. K. S. Clinton (formerly Plant Pathologists in those areas); for the data on harvesting experiments, and for groundnut growth studies, and for their numerous suggestions and help I am grateful to my colleagues on the Experimental Stations in the Corporation's three areas.

The Agricultural Research Council supplied the majority of the samples of fungicide materials. A number of references were provided by the Commonwealth Mycological Institute.

REFERENCES

[1] Overseas Food Corporation (1949). Report and Accounts for 1948–49. London. H.M.S.O.

[2] Overseas Food Corporation (1950). Report and Accounts for 1949–50. London. H.M.S.O.

[3] Overseas Food Corporation (1951). Report and Accounts for 1950–51. London. H.M.S.O.

[4] Miller, L. I. Peanut Leafspot Control. Virginia Agr. Expt. Sta. Tech. Bull. 104 (1946).

[5] Wolf, F. A. Leafspot and some Fruit Rots of Peanut. Alabama Agr. Expt. Sta. Bull. 180 (1914).

[6] Wolf, F. A. Further Studies on Peanut Leafspot. J. Agr. Res. 5: 891–902 (1916).

Table I

Effect of residue disposal and cultivation treatments on persistence of *Cercospora* infection.

	Lesions per 100 Plants	
	Day 10	Day 12
Residue Treatments—		
No groundnuts in previous season	11	53
Residue carted off	480	816
All residues left	590	851
Cultivation Treatments—		
Ploughed June and December	272	484
Ploughed June, disced December	316	452
Ploughed December	296	688
Disced December	384	672

Table II

Effect of *Cercospora* infection on the yield of groundnuts (variety "Natal Common"). Kongwa 1952.

	Days to "maturity"	Yield, kernels lb./acre	Leaves per plant at harvest	No. of pods per kilo	Shelling per cent	Oil per cent in kernels
Disease-free	112	1,456	71	1,159	68·8	45·4
Diseased	94	1,118	18	1,282	67·0	43·8
Significant Differences—						
5 per cent	—	300	14	97	2·2	—
1 per cent	—	444	21	143	3·2	—

	Mature pods per plant	Partly formed pods per plant	Swelling gynophores per plant	Pegs (not swelling) per plant
Disease-free	26·4	3·8	7·0	14·8
Diseased	19·0	3·2	5·2	7·5
Significant differences—				
5 per cent	4·1	1·4	1·5	1·2
1 per cent	6·0	2·0	2·3	1·8

Table III

Effect of harvesting at six different dates on yield and gleanings. (Nachingwea, 1952)

Days to harvest	Plant number 000/acre	Kernels stooked lb./acre	Kernels gleaned lb./acre	Total kernels recovered lb./acre	Shelling Percentage per cent
85	26·1	782	10	792	68·4
91	26·4	915	17	932	72·2
97	26·8	1,012	8	1,020	71·7
103	25·1	819	52	871	71·9
109	23·3	877	106	983	74·0
115	22·5	760	168	928	73·3
Significant differences—					
5 per cent	1·9	146	13	128	1·7
1 per cent	2·7	199	18	174	2·4

Table IV

Effect of harvesting at eight different dates on yield. (Kongwa and Urambo, 1951.)

Kongwa, 1951

Days to harvest	Kernels, lb./acre (±49·1)	Plant number, 000/acre (±0·89)	Kernels, per cent pods (±0·65)	Oil, per cent kernels (±0·25)	Oil, lb./acre (±21·6)
84	562	40·0	65·1	41·6	235
89	698	43·9	68·8	43·6	305
94	889	44·8	68·9	43·6	388
99	884	42·7	71·2	44·6	394
104	959	41·3	73·1	44·2	425
109	990	44·0	73·1	43·2	428
114	1,041	42·6	73·8	43·4	452
119	1,023	39·9	73·5	43·5	446
Significant differences—					
5 per cent	141	2·6	1·9	0·6	62
1 per cent	189	3·4	2·5	0·9	83

Urambo, 1951

Days to harvest	Kernels, lb./acre (±35·4)	Plant number 000/acre (±1·50)	Kernels, per cent pods (±1·35)
84	325	48·8	47·5
89	503	49·5	58·5
94	862	46·7	65·5
99	951	49·7	67·2
104	979	50·3	69·5
109	1,252	46·5	72·3
114	1,003	45·6	73·3
119	900	42·3	71·5
Significant differences—			
5 per cent	102	4·3	3·9
1 per cent	137	5·8	5·2

ACACIA SPP. AS SHADE TREES FOR COFFEE

By J. K. Robertson, Department of Agriculture, Tanganyika Territory

(*Received for publication on 17th December, 1953*)

In the Northern Province of Tanganyika it is generally held that Arabica coffee, particularly at the medium and lower elevations, does better and gives consistently higher yields when grown under light shade. There is less danger of over-bearing with consequent die-back, the incidence of insect pests such as Thrips and White Stem-borer (*Anthores leuconotus*) is usually less and weeding costs are generally far lower in shaded coffee especially if weeds such as Couch (*Digitaria scalarum*) or Water-Grass (*Cyperus rotundus*) are present in the area.

The difficulty, of course, has been to find a suitable shade tree. The indigenous Mruka (*Albizzia maranguensis*) is generally regarded as the best coffee shade tree for Northern Province conditions but although Mruka gives very good results in its natural habitat, it is a difficult tree to establish and does not do well in the hotter, drier areas where shade for coffee is so essential. *Cordia holstii* is regarded as a close second to Mruka as a shade tree for coffee but after that the list of beneficial shade trees tails away very rapidly. How *Grevillea robusta* ever came to be recommended as a shade tree for coffee makes one wonder (unless it be the ease with which it is grown) since its rightful role is rather that of a tree for windbreaks.

My attention was first drawn to the possibility of using *Acacia* spp. as shade trees for coffee when seeing the good growth and consistently good cropping of coffee grown under self-sown *Acacia spirocarpa* in certain parts of the Southern Highlands Province of Tanganyika. Observations made recently in the Tengeru/Usa River area of Tanganyika's Northern Province have shown how well coffee in this region (average annual rainfall, 51 in.) grows and crops when shaded with *Acacia sieberiana.*

Acacia sieberiana gives a diffuse light shade which never encourages spindly growth in coffee yet which is apparently heavy enough to discourage Couch which so readily becomes established in under-shaded coffee. This diffuse light shade is particularly suitable for coffee grown on the multiple-stem system since it is well known that multi-stem coffee requires lighter shade than does single-stem coffee if best results are to be achieved. It does not suffer from the disadvantage of several recognized coffee shade trees, e.g., Mruka and Msesewe (*Rauwolfia inebrians*) in becoming entirely leafless for a period every year and thus allowing weeds to become established in the coffee. The *Acacias* of the lower rainfall areas are exceptionally deep rooted and, as such, should show little competition with the coffee for available soil moisture and plant nutrients. Planters in the Usa River/Tengeru area when asked why they have not planted up more of this species of *Acacia* in their coffee have invariably replied that the tree is slow growing, but that criticism holds true for all good shade trees since it is most unusual to find a quick-growing shade tree that does not compete with the coffee underneath. When making new plantings of coffee it is advisable to plant the temporary shade (such as *Leucaena glauca*) at the same time as the permanent shade, temporary shade, of course, being removed later.

Acacia sieberiana produces seed in profusion and the seedlings are easy to raise.

Search among the records of shade trees recommended for coffee does not show any mention of *Acacia* spp. ever being used or recommended for this purpose; further search in the genus *Acacia* may reveal other species suitable as shade trees for coffee since the genus is an extensive one.

I am indebted to Dr. P. J. Greenway, F.L.S., Botanist, E.A.A.F.R.O., for botanical identification of the tree in question.

Note.—Acacia albida (local name *Mpogoro*) is used successfully as a coffee shade tree in certain parts of the Southern Highlands Province, having an annual rainfall of 50 to 60 inches.

THE SECOND FOREST NURSERY COURSE—MUGUGA, 1953

The second Forest Nursery Course was held at Muguga in mid-November, 1953. The reason for the course was that extensive touring in the territories by specialists had shown that with many forest nurseries varying results were being obtained by different methods, and similar results by varying methods. Further in the E.A.A.F.R.O. nursery the effect of varying local conditions on the basic principles of nursery work were beginning to show results. It was thought that in general nursery work throughout the territories could be improved and that, for this, a better understanding of these basic principles was needed. The first course, held in 1952, had been much appreciated, and the Forest Technical Co-ordinating Committee therefore asked E.A.A.F.R.O. to repeat it.

This second course lasted for ten days, and included theoretical discussions and practical demonstrations in the E.A.A.F.R.O. research nursery and the Muguga forest department nursery. Towards the end of the course one-day visits were made to forest centres of interest. Owing to the Emergency, arrangements were difficult, but in spite of this the course was attended by 17 forest officers and foresters from the three mainland territories. Talks were given by various E.A.A.F.R.O. specialists and other outside officers, to all of whom we are most grateful. The benefits of a course such as this are very great, for it gives a chance to a group of technical officers who normally lead very lonely lives to get together, to know each other and to discuss their many problems. These problems are inter-territorial and each territory can help the others with its experience; and, from the E.A.A.F.R.O. point of view, by these criticisms we get to know a great deal of the problems that need to be dealt with and their priority. We have not the staff or funds to do all that should be done, and from a course like this we get an indication of what work is likely to be most useful.

The extension of the course from a week to ten days proved well worth while although it was still fairly concentrated. Excursions were made to see the work of the Kenya Forest Department in a dry, eroded district at Kiteta, beyond Machakos, softwood nursery and plantation work at Uplands, Kerita and Kinale, and softwood-tending, such as pruning and thinning, at Elburgon and Mariashoni.

Most of the delegates were accommodated in Muguga House (the E.A.A.F.R.O. Hostel) and social activities such as a sundowner, two evenings of Scottish dancing, etc., provided an antidote to too much work.

The course was voted a great success, and the interest in it was shown in the discussion at the final session and the criticisms and suggestions which were made for the next course. About a quarter of the foresters and forest officers of East Africa have now attended one or other of these two courses, and we hope to hold a third in November, 1954. We very much appreciate the efforts of all those who helped to make the course "go" both in work and socially.

As I said last year, the moral of the course is that good nursery work means bigger, better, cheaper and quicker plants, and this in turn means better plantations that are easier and cheaper to tend. This object can only be achieved if the basic principles of the job are understood and applied to local conditions.

We hope that the next course will also be attended by a few local farmers or others interested, for at least part of the time, since farm forestry is essential to the welfare of East Africa, and the basis of good farm plantations, windbreaks, shelter belts, etc., is a good farm forest nursery.

A. L. GRIFFITH.

REVIEWS

ELEMENTS OF FOREST ECONOMICS, by Sven Petrini, translated by Mark L. Anderson, published by Oliver & Boyd, Edinburgh and London, 1953, price Sh. 22/6.

Sweden has been practising scientific forestry for many centuries, and Prof. Petrini has made a life study of the economics of the forestry business. The first text-book that he published in forest economics was in 1937 for the Royal Technical High School, and this present volume is a revision written in 1946 and translated into English in 1953.

Although in East Africa we will be many years before we get to the economic stage of Sweden, yet from the start a lesson stands out that we should appreciate and that is the difference between the economics of private and estate forestry, i.e., the forestry of the farmer and the forestry of the country. A farmer must supply himself with wood products and get his returns quickly and certainly, whereas the State can afford to wait a long time for its money returns and can afford the expenditure necessary to help the farmer.

The book is divided into two parts, the first rather general and fundamental, whereas the second is more specific, applied and practical. In the first part, calculations have been transcribed into shillings per acre, whereas in the second half calculations have been largely left in kronen per hectare as it is more convenient for workers in Scandinavia and the Continent generally for whom the book is written.

To us in East Africa the summary is well worth studying even if we do not take the trouble to go through the earlier, more technical calculations. It is emphasized that the modern tendency is not to grow the timber giants of the past, but that forestry is more and more tending to be an industry producing smaller and smaller wood, quicker and quicker, to supply a raw material to the chemical industry. The present tendency is that cellulose and its derivative, the plastic industry, and the as yet unsolved lignin problem, will be greatly developed in the near future, but at the same time the demand for fuel and construction timber goes on. It also states that it is likely that in the future, quantity production will outweigh quality production. How does this affect us here? Should we go on with our complicated thinning and pruning of softwoods to produce good quality, or should we put our effort more into quantity production? The book further stresses that it pays better to be in possession of a forest of good quality because its field of usefulness is much greater, its produce is of higher value and in particular because the costs of looking after it are lower. This latter point is one often lost sight of in East Africa, especially in view of our rotations being so much shorter than those of Scandinavia. If and when over-production of timber takes place, then it will be extremely advantageous to be in possession of high-class timber which always finds a good market. At present the world is very far from the stage of over-production.

The summary goes on to point out that the responsibilities of the State are to see that the forest resources are maintained or improved, to see the working opportunities of the people and export trade are not subjected to dangerous upsets, and above all to see that in case of catastrophies such as war, when the welfare of the whole nation is at stake, that this has not been jeopardized by faulty policy in the past.

The book is well produced and clearly printed, and in spite of the difficulties of the subject it is very readable. The author is to be congratulated on his revision, and Dr. Anderson on his translation. The book should find a place not only in forest libraries, but should be read and studied by all who have the future of a country and its people to consider.

A. L. GRIFFITH.

SOIL SURVEYS FOR LAND DEVELOPMENT, edited by C. G. Stephens, F.A.O. Agricultural Studies No. 20. United Nations, Rome, Sh. 5.

This small inexpensive booklet is in the reviewer's opinion the soundest exposition of this subject which has yet appeared. Though primarily written for the administrator it can be read with profit by the scientific agricultural worker, the intelligent farmer and the well-informed layman. Twenty eminent soil men in all parts of the world have contributed to this booklet while 19 others criticized it in draft. The style is sober, matter of fact, and the substance solid and incontrovertible.

It falls into four main parts—the purposes of soil classification, the techniques of soil surveying, classifying soils and the administration of soil investigation. The technique of soil surveying and the classifying of soils are treated thoroughly and on practical lines. Well-taken photographs and a few easily understood charts illustrate the main points discussed.

The purposes of soil classification are classed under three main heads, Agricultural, Engineering and Scientific, the former being elaborated under the headings, Soil Management, Land Settlement, Irrigation, Salinity, Animal and Human Diseases, Sylviculture, Taxation and Soil Modification. The discussion of the scientific purposes of soil classification is in the reviewer's opinion somewhat too short and not enough is made of the essential relation between science and practice. There are soils and soils, and the aim of pure science is to discover why without immediate regard to practical value. With progress in the scientific classification of soils the subject becomes more intelligible and practice is guided.

The booklet stresses that the overwhelming basic need for soil surveys is to supply the link between research and the farmer. There are many instances in this as in more civilized countries where the applicability of research results are in some doubt because of soil differences. Soil surveys can be of any degree of detail but usually entail either detailed survey in settled areas and in areas intended for irrigation development or broad reconnaissance surveys as a means of specifying the total soil resources of a country, assessing the potentialities of a district or region, and surveying an area prior to detailed survey in part or whole.

The idea of soil survey or soil reconnaissance is often very hard to "sell" in East Africa, but proof of its value comes in many ways. Farmers very often see their soils for the first time when their soil types are explained and themselves offer explanation of anomalous soil behaviour which had previously baffled them. A group of farmers can become so soil conscious that they organize a local soil museum and start experiments on their main soil types. On the basis of soil reconnaissance fertilizers have been subsidized on certain soil types, irrigation projects modified in the light of soil salinity data.

In conclusion the booklet makes the following serious pronouncement. The most valuable national asset in any country is its soil. If soil is well managed its fertility is not only renewable but improvable. If it is misused the soil can be permanently damaged or irretrievably lost. With the world's population steadily rising the necessary agricultural and forest products to feed, clothe and house it can be assured only by a systematic increase in production on existing farms and by a considered programme of development of unoccupied land capable of production. Such a programme calls for a national inventory of the soil resources of every country.

W.E.C.

PATURAGES ET FOURRAGES TROPICAUX. FASCICULE I. PATURAGES TROPICAUX.

TROPICAL PASTURES AND FORAGE PLANTS. PART I. TROPICAL PASTURES.

Par B. Havard Duclos, Ingénieur Agronome et d'Agronomie colonial, Professeur à l'Ecole Supéieure d'Application d'Agriculture tropicale. Published by La Maison Rustique, Paris.

The book, which is divided into seven chapters, contains the description and classification of tropical pastures, or, rather, grasslands, their utilization, improvement and the establishment of artificial pastures.

The classification of the pastures is based upon climate, soil and the vegetation and hence three divisions are offered. The main division is based upon the vegetation, and represents an enumeration of the main types of the tropical grasslands illustrated by examples from Madagascar. The wooded and the treeless grasslands are the main units. Wooded grasslands are divided into dry forests, tree savanna, bush savanna and park savanna. The treeless types are: prairies, as more moist grasslands of high altitudes; and steppes, as semi-desert types found at lower altitudes. Generally speaking, the classification is quite natural and easy to follow. The classification and description of tropical grasslands constitutes a considerable part of the book and is illustrated by numerous well-chosen but very small photographs. The composition of the flora of tropical pastures is briefly outlined and the main genera of the grasses are indicated. The author states that almost complete absence of leguminous plants is a characteristic feature of tropical pastures, an opinion with which one can hardly agree. A separate chapter deals with the mineral deficiency of tropical pastures.

In the part of the book dealing with the utilization of tropical pastures the author offers rather an ingenious but not always applicable formula, for assessing grazing capacity in the tropics, which is said to be used in Africa. It said that the number of hectares required to support one head of adult cattle should be at least equal to the number of months in the dry season. This rule, though occasionally true, would probably underestimate considerably the grazing capacity of the land in many regions of Kenya.

Describing the utilization of pastures in the tropics the author compares favourably grazing in paddocks with open grazing. However, the only example which illustrates the advantages of grazing in paddocks is taken from the results obtained in the temperate zone (North Dakota, U.S.A.) and these results are not too convincing. In the same chapter various systems of night paddocking are compared. The construction and the cost of several types of fencing is described in detail on five pages and this is rather surprising in a small book dealing with general problems concerning tropical pastures.

In the chapter dealing with the improvement of the tropical pastures, improvement by grazing management, manuring and mowing are considered. This part and the whole book is concluded with a chapter on artificial pastures, their establishment and the eradication of pasture weeds. The preparation of the soil for planting is described in detail.

The book cannot be considered as a manual on tropical pastures, since in a small volume of 88 pages one can hardly expect to find any detailed review of all problems connected with tropical pastures and their utilization. The author merely outlines the main problems of the subject, illustrating them with the material which he finds deserving particular attention. Hence the chapters are not uniform and, apparently in accordance with the author's inclinations, some parts contain much more detail than the others. In general, the book is interesting and deserves attention of all who deal with pasture problems in the tropics. Unfortunately it does not contain references to any published works the results of which are discussed and it can only be guessed to what extent the main literature on the tropical pastures has been used. Of the East African literature only the results of rather old publications have been mentioned while the recent works seem to be omitted.

A.V.B.

Legumes in Agriculture, by R. O. Whyte, G. Nilsson-Leissner and H. C. Trumble, F.A.O. Publication, Rome, 1953.

Whilst the authors claim that "this is not intended to be a textbook on legumes but rather to indicate the problems . . . engaging the attention of agronomists and others in many parts of the world", it is a publication which can be read with profit both by the research worker and the farmer in East Africa. Wherever possible the emphasis has been on the problems of legumes in tropical and sub-tropical regions and one chapter of 60 pages is devoted to replies to a questionnaire by workers in these areas.

The text, which covers a wide field, from ecological requirements of ley legumes to their economic utilization, is divided into two parts. Part I deals with the climatic and soil factors influencing growth, nodulation and nitrogen fixation, the effects of legumes on soil fertility and their value for soil conservation. In discussing their value for feeding livestock, the authors deal with their extensive use as browse plants, their importance in mixed grass-legume pastures in many countries and climates, their intensive use in leys and alternate husbandry systems, methods of conservation as hay, silage and dehydrated herbage. The food value of leguminous grains for both man and his animals are commented upon whilst a chapter is devoted to legumes poisonous to livestock.

Part II gives for the more important legume species of many genera a summary of their morphological characteristics, climatic and soil requirements, economic uses and distribution.

This publication is illustrated with many photographs whilst scattered throughout are details of seeding rates, yields, and composition and feeding values.

Although one will notice many omissions, this is inevitable when condensing the world bibliography into a single publication and the authors are to be complimented on their comprehensive review of tropical and sub-tropical legumes and their relationships to those of other regions. Whilst it is concluded that there is considerable scope for the selection and breeding of improved strains within the wide range of existing genera and species, the publication does not contain the answer to those seeking information on the best types of grazing legumes and the proper systems of management under East African conditions. Nevertheless, it is both humiliating and stimulating to learn how little is known about legumes in tropical and sub-tropical countries.

M. H. F.

REVIEWS IN BRIEF

INSETTI DANNOSI ALLE COLTIVAZIONI IN SOMALIA (Insect Pests of Crop Plants in Somalia), By F. Beccari, L. Bozzi and U. Funaioli, 1953. Obtainable from Amministrazione Fiduciaria Italiana della Somalia, Mogadiscio, Somalia.

This booklet of 42 pages gives descriptions, with coloured illustrations, of the insects which attack cotton, maize, sesame ("sim-sim"), bananas, and citrus fruits, and the damage caused is also described and illustrated.

DISEASES OF FRUIT AND VEGETABLES IN THE ANGLO-EGYPTIAN SUDAN, by S. A. J. Tarr. Bulletin No. 8. Ministry of Agriculture, Sudan Government. Price P.T. 30.

Includes chapters on prevention and control of plant diseases: diseases of citrus and other fruits; diseases of vegetables, and notes on fungicides. The text is illustrated by 21 photographs.

THE PAPAW: ITS BOTANY, CULTIVATION, DISEASES AND CHEMISTRY, by P. J. Greenway, G. B. Wallace, M. M. Wallace, and E. V. R. Khomo, Tanganyika Department of Agriculture, Pamphlet No. 52. Obtainable from the Government Printer, Dar es Salaam, Tanganyika Territory. Price Sh. 3.

This pamphlet contains four papers: "The Papaw or Papaya"; "Papaw Culture"; "Diseases of Papaw and their Control"; and "Chemical Aspects of Papain". The first three are revisions of articles which appeared in this JOURNAL, Vol. 13, No. 4, April, 1948, while the fourth is an original contribution.

DAIRY PRODUCE. A summary of figures of production, trade and consumption relating to butter, cheese, condensed milk, milk powder, casein, eggs, egg products, margarine. Compiled in the Intelligence Branch of the Commonwealth Economic Committee. London, 1953. H.M. Stationery Office. Price Sh. 5.

MEAT. A summary of figures of production, trade consumption, relating to beef, live cattle, mutton and lamb, live sheep, bacon and hams, pork, live pigs, canned meat, offals, poultry-meat. Compiled in the Intelligence Branch of the Commonwealth Economic Committee. London, 1953. H.M. Stationery Office. Price Sh. 5.

PROCEEDINGS OF THE SOCIETY FOR THE STUDY OF FERTILITY, No. IV. London Conference, 1952, published by W. Heffer & Sons, Ltd., Cambridge. Price Sh. 10.

Fifteen papers on fundamental studies of fertility problems in man and animals.

AGRICULTURE FOR AFRICANS. I—THE SCHOOL GARDEN, by G. H. Chaundy, published by Macmillan & Co., Ltd., London, 1953. Price Sh. 2/6.

The text, which is written in both English and Kiswahili, describes in simple language the vegetable garden, fruit-growing, insect pests, plant diseases, and poultry-keeping.

AGRICULTURE FOR AFRICANS. II—INSECT PESTS AND PLANT DISEASES, by G. H. Chaundy, published by Macmillan & Co., London, 1953. Price Sh. 2/9.

This book, written in English and Kiswahili, gives simple explanations of insect pests and their control, plant diseases and their remedies, and recent work on pest and disease control.

THE JOURNAL OF THE WEST AFRICAN INSTITUTE FOR OIL PALM RESEARCH, Vol. I, No. 1, September, 1953. Obtainable from the Director, West African Institute for Oil Palm Research, Benin City, Nigeria, and the Crown Agents for the Colonies, 4 Millbank, London, S.W.1. Price Sh. 2/6.

Contents.—The Institute; observations on the influence of some ecological factors on the incidence of oil palm diseases in Nigeria; controlled pollination of the oil palm; field planting of oil palms; methods of germinating oil palm seeds; with additional notes and reviews.

NOTES FOR FIELD STUDIES OF TSETSE FLIES IN EAST AFRICA. Compiled and issued by the E.A. Tsetse and Trypanosomiasis Research and Reclamation Organization, P.O. Box 2141, Nairobi.

This is an *aide memoire* for field workers who have already had some training in tsetse work. It contains chapters on the biology of tsetse flies; tsetse survey; vegetation; special techniques; and the East African species of tsetse flies.

THE EAST AFRICAN AGRICULTURAL JOURNAL

VOLUME NINETEEN
1953—1954

1954
PRINTED BY THE GOVERNMENT PRINTER
NAIROBI, KENYA COLONY

THE EAST AFRICAN AGRICULTURAL JOURNAL

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